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New Zealand Geographer

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THE GEOGRAPHICAL STATUS OF NEW ZEALAND LOWLAND FOREST VEGETATION

V. J. CHAPMAN

FROM TIME TO TIME it is highly desirable to re-examine current concepts because, occasionally, ideas become so established that they are regarded almost as immutable. For a long time now the views of Cockayne have coloured New Zealand botany, not least his views on the nature and status of New Zealand forest vegetation. Whilst the contribution that Cockayne has made in this field cannot be decried, nevertheless new techniques have been developed and much information has subsequently come to hand, not only from studies of New Zealand vegetation but also from those of tropical vegetation.

Cockayne can, in particular, be regarded as responsible for two important ideas about New Zealand lowland forest vegetation, ideas that have tended to influence all thinking and interpretation of facts by botanists in this country. The first concept is that, at the present time, there is a decline in the podocarp element of the northern lowland forest, and an increasing dominance of broadleaf species, the transition being the final stage in a plant succession. On this basis, podocarp forest does not represent the climax forest of New Zealand, this position being rightfully occupied by broadleaf species such as tawa (*Beilschmiedia tawa*), taraire (*B. taraire*) and kamahi (*Weinmannia racemosa*). The same interpretation has also been applied to the northern kauri forests.

The second concept originating from Cockayne is the idea that the northern lowland, mixed evergreen forests, whether dominated by kauri, podocarps or broadleaf species, represent subtropical rainforest. It is now claimed that neither of these concepts is correct and that it is time they ceased to colour the New Zealand botanist's interpretation of lowland forests. A brief analysis of the position has already been made,[1] but recent work by Robbins[2] has clarified the situation still further.

For the purposes of the present discussion, four major types of forest can be recognised in New Zealand.[3] They are as follows:

(a) Mixed evergreen dominated by kauri (*Agathis australis*).

(b) Mixed evergreen dominated by podocarps, of which rimu (*Dacrydium cupressinum*) is the most significant. McKelvey and Nicholls subdivided this group into forest dominated by dense rimu, scattered rimu, scattered rimu and matai (*Podocarpus spicatus*), and Hall's totara (*Podocarpus hallii*).

(c) Mixed evergreen dominated by dicotyledonous trees other than southern beech, for example, tawa, taraire, kamahi. In this group one must also include coastal forest, dominated in the north by pohutukawa (*Metrosideros excelsa*) and in the south by kohekohe (*Dysoxylum spectabile*).

(d) Evergreen forest, pure or mixed, dominated by one or more species of southern beech (*Nothofagus* spp.)

Within these forest types the most interesting community is the mixed podocarp–broadleaf, because it is this community which is regarded as exhibiting the characteristics of subtropical forest, and also as being indicative of podocarp replacement by broadleaf species in the final change of the succession. Recently Robbins[4] has employed the profile method, as used for tropical forests by Davis and Richards,[5] in an analysis of more than fifty different forest stands, primarily in lowland forest of the North Island of New Zealand. As a result of this intensive survey, Robbins has pointed out that three forest series can be recognised.

The first series (A) in the lowland forest commences with forests growing on relatively young soils, mainly on the Volcanic Plateau, dominated by matai (*Podocarpus spicatus*) and totara (*P. totara*). With increasing development and maturity the species of *Podocarpus* are replaced by rimu (*Dacrydium cupressinum*). The rimu is subsequently

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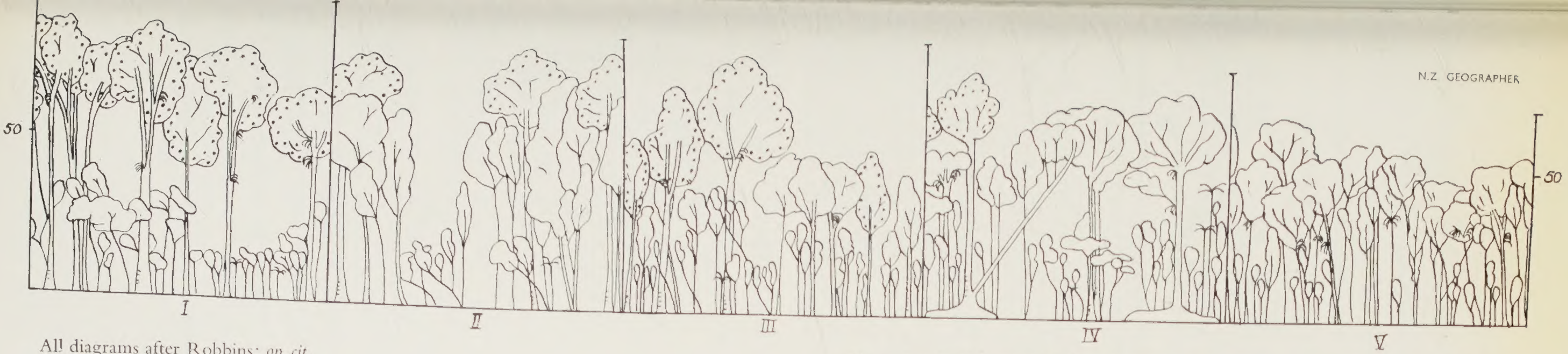
[1] V. J. Chapman: 'The Status of New Zealand Forest Vegetation', *Angewand. Pflanzensoz.*, Vol. 2, 1954, pp. 971-977.

[2] R. C. Robbins: *The Status and Classification of New Zealand Forest Vegetation*, Unpublished Ph. D. Thesis, University of New Zealand, 1957.

[3] Robbins: *op. cit.*, and P. McKelvey and Nicholls: 'A Provisional Classification of North Island Forests', *N.Z. Journ. Forestry*, Vol. 7, No. 4, 1957, pp. 84-101.

[4] Robbins: *op. cit.*

[5] T. A. W. Davis and P. W. Richards: 'The Vegetation of Moraballi Creek, British Guiana', *Journ. Ecol.*, Vol. 21, 1933, pp. 35-95, and *ibid.*, Vol. 22, 1934, pp. 106-155.



All diagrams after Robbins: *op. cit.*

Fig. 1. Lowland forest series from pure podocarp (I) to pure broadleaf forest (V): I. Forest at the southern end of Taupo; II. Forest at Waikaremoana; III. Forest on the Tararuas; IV. Forest in Taranaki; V. Forest in North Auckland. (Podocarp species are stippled.)

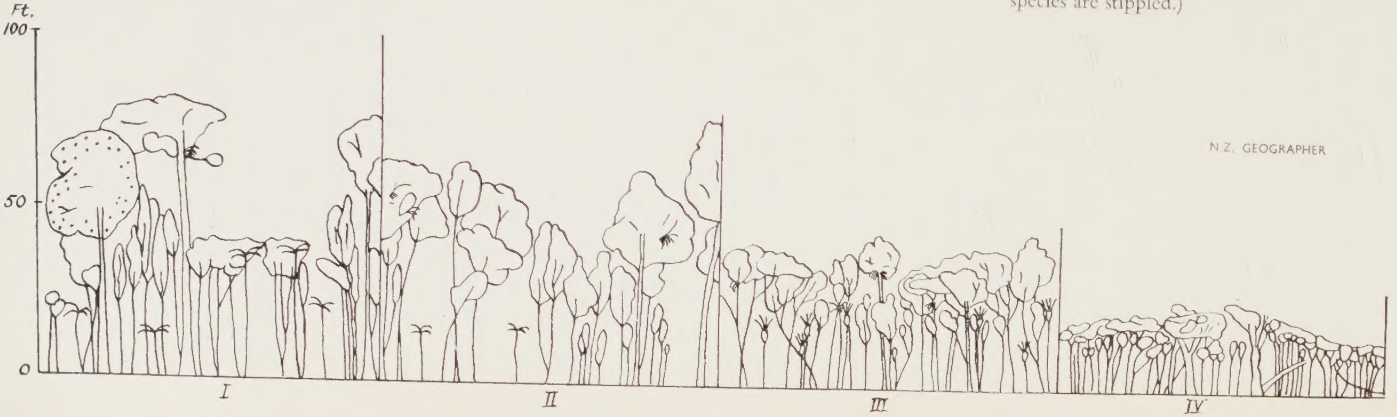


Fig. 2. Lowland forest series inland to the coast (the full inland stage being represented in I above): I. Forest at Nelson; II and III. Forest at Paraparaumu; IV. Coastal scrub on an island in Cook Strait. (Podocarp species are stippled.)

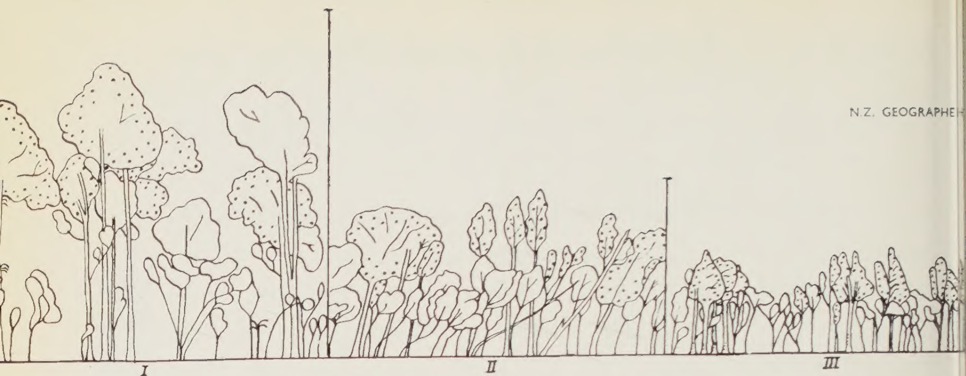


Fig. 3. Lowland to montane forest series: I. Forest on the Rimutaka Range at 1,500 feet; II. Forest on Mt. Cargill at 2,000 feet; III. Forest on Mt. Egmont at 3,000 feet. (Podocarp species are stippled.)

invaded by rata (*Metrosideros umbellata*) and also by broadleaf species, so that when the rimu–rata combinations die, a broadleaf forest remains (*Fig.* 1).

In the case of kauri forest the story is slightly different. The pioneer stage is manuka scrub (*Leptospermum scoparium*), then manuka–broadleaf forest (*L. scoparium, L. ericoides–Knightia excelsa, Aristotelia serrata*) followed by manuka–ricker kauri, and then by mature kauri in which either tawa or taraire occur. As the kauri die, tawa or taraire are expected to assume final dominance.

The second lowland forest series (B) can be traced from the inland podocarp or rimu forests, or mixed forests, out towards the coast. Gradual elimination of the podocarps occurs, presumably as a result of salt spray, and they are replaced by a canopy of coastal broadleaf species, which, very close to the coast, is often transposed to a coastal scrub (*Fig.* 2). The third series (C) is that from lowland podocarp forest to alpine scrub. In this series the lowland podocarps are replaced by mountain podocarps (*P. nivalis, Dacrydium biforme, Phyllocladus alpinus, Libocedrus bidwillii*) and not by broadleaf (*Fig.* 3). These second and third series are quite clearly environmental and comparable with similar series described by Beard[6] for the West Indies.

The point at issue is whether the first series represents a true ecological succession—as Cockayne believed—or whether there is another interpretation. In the mixed podocarp or kauri–broadleaf forest, are the so-called light-demanding pioneer gymnosperm trees being replaced by shade-tolerating broadleaf species which form the climax? If Cockayne's interpretation of series A is correct, it is apparent from profile diagrams (*Fig.* 1) that the postulated climax is a forest lower in stature, simpler in structure and poorer floristically than its immediate predecessor, the mixed podocarp–broadleaf. This ecologically is an anomalous situation, and because of this anomaly alternative hypotheses have been put forward in recent years.

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[6] J. S. Beard: 'The Classification of Tropical American Vegetation Types', *Ecology*, Vol. 31, No. 1, 1955, pp. 89–99.

Cyclic-Alternation Hypothesis

The first hypothesis can be termed the *cyclic-alternation hypothesis.* This suggests that there is a regular alternation of gymnosperm and broadleaf species. In 1939 Poole[7] suggested that in Westland forests rimu alternated with *Quintinia acutifolia* and kamahi (*Weinmannia racemosa*). In 1946 Holloway[8] put forward a similar explanation for the Longwood Range in Southland with the podocarps alternating with southern rata (*Metrosideros umbellata*) or *Weinmannia.* More recently Holloway has abandoned this interpretation for one of recent climatic change. Various studies of kauri forest do, however, suggest quite strongly that in this particular type of vegetation there is a cyclic alternation between the kauri and broadleaf species. The evidence in support of this comes from a study of soils in kauri areas, ecological studies, and studies in regeneration of the kauri.[9]

Regional Climatic Change

The second hypothesis is that of *regional climatic change.* This was propounded by Holloway[10] in 1954 on the basis of studies in the South Island and, more particularly, of western Southland. Here beech is replacing podocarps, and this replacement is regarded as a result of comparatively recent changes in a regional climate. The change of climate has not favoured the podocarps and they have ceased to regenerate effectively, so that the broadleaf species are invading successfully. Matai (*P. spicatus*) was the first tree to be affected by this change, and old trees and forest pockets of the species are regarded as relics. Holloway has suggested that this sudden climatic change took place about 1200 A.D. It was, according to him, most pronounced in the

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[7] A. L. Poole: 'A Brief Ecological Survey of the Pukekura State Forest, South Westland', *N.Z. Journ. Forestry*, Vol. 4, No. 2, 1937, pp. 78–85.

[8] J. T. Holloway: 'Forest Associations of the Longwood Range, Southland', *ibid.*, Vol. 5, No. 3, 1946, pp. 199–209.

[9] R. V. Mirams: 'Aspects of the Natural Regeneration of the Kauri (*Agathis australis* Salisb.)', *Trans. Roy. Soc. N.Z.*, Vol. 84, Pt. 4, 1957, pp. 661–680; and R. L. Bieleski: *Experimental Studies on Factors affecting Growth and Distribution of Kauri*, Unpublished M.Sc. Thesis, University of New Zealand, 1955.

[10] J. T. Holloway: 'Forests and Climates in the South Island of New Zealand', *Trans. Roy. Soc. N.Z.*, Vol. 82, Pt. 2, 1954, pp. 329–410.

South Island, but it is suggested that a diminishing effect can be observed as one travels to the North Island. It could be expected that such a regional climatic change would be reflected in the pollen analyses made from peat bogs where it would possibly represent what is known as a 'recurrence horizon' (*Grenzhorizont*). It is true that pollen analysis does show vegetation change since the retreat of the ice in the post-Pleistocene, but the last major change of climate and vegetation is placed at about 2,000–3,000 years ago. Other arguments can be presented to support or oppose the above hypothesis. Whilst there may indeed be evidence of local climatic change in the South Island, around 1200 A.D., there is much less evidence that this change will account for a general replacement of podocarps by broadleaf species.

Mosaic Regeneration Hypothesis

The *mosaic regeneration hypothesis* represents a third alternative. According to this there is a regular cycle of vegetational change, but each piece of the vegetation is likely to be at a different stage in the cycle at any given moment of time. In an evenly-aged exotic forest the process would be general and only one stage present at a given time; in natural forest where trees are of all ages, the phases form a mosaic. In tropical and subtropical forests where this hypothesis has been applied, it is the composition of the topmost, or A stratum, which exhibits this mosaic. In other words one species of stratum A is replaced by another species of stratum A. In the New Zealand lowland forest, however, the situation is rather different. In the mixed podocarp–broadleaf forest the podocarps form the A stratum and the broadleafs the A_2 stratum. When the podocarps disappear the A_2 broadleaf layer becomes the A stratum of the broadleaf forest. In other words an A stratum is replaced by an A_2 stratum (*Fig.* 4).

Broadleaf Forest Dominance Hypothesis

A fourth alternative has been termed by Robbins[11] the *broadleaf forest dominance hypothesis*. On this hypothesis the mixed podocarp-broadleaf forest is regarded as the result of the fusion of two separate forest types, distinct in origin, history, composition, structure and biology. Because of this origin it is regarded as unstable, and a slight change in the environmental conditions could allow either of the original forest types to suppress the other. At the present time conditions may be favouring the broadleaf forest. There are then two major forest types: first, the ancient gymnosperm forest (podocarps, kauri), which probably originated in the old continent of Gondwanaland; second, the geologically more recent broadleaf forest which entered from the north. Both can still be found in pure form, but in many places they have fused. On this interpretation the original series A (*Fig.*1) does not represent a succession, cyclic alternation or mosaic, but could perhaps be called an historical gradient.[12]

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[11] Robbins: *op. cit.*

It would seem from the distribution of the lowland forests that the gymnosperms (podocarps) are the first forest occupants of poor soils, such as are found in the central plateau of the North Island. Under successive podocarp crops, what may be termed the habitat potential is built up, and then broadleaf forest is able to compete with the podocarps, and so one finds a fusion of the two (*Fig.* 5).

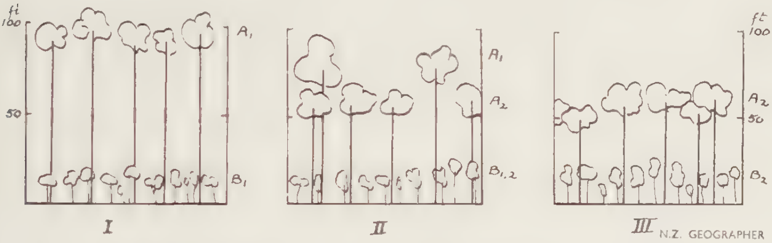

Fig. 4. Diagram to illustrate the change in forest structure: I. Pure two-storey podocarp forest; II. Mixed three-storey podocarp-broadleaf forest; III. Pure two-storey broadleaf forest

A brief summary of present knowledge in respect of the development of the New Zealand flora will allow an appreciation of how the two basic types of forest arose, and it will also serve as a background to the discussion of the second concept, namely, the status of the lowland forest.

DEVELOPMENT OF NEW ZEALAND FLORA

In general, three main floras[13] can be recognised in the geological history of New Zealand. The first is the Permo-Mesozoic, which flourished from the lower Permian to the early Cretaceous. Nearly half the known Jurassic species belonged to the gymnosperms (Araucariaceae and Podocarpaceae) together with ferns, cycads and seed ferns (Pteridosperms). The gymnosperms probably originated in

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[12] *ibid.*

[13] W. R. B. Oliver: 'History of the Flora of New Zealand', *Sven. Bot. Tids.*, Vol. 49, Nos. 1-2, 1954, pp. 9-18.

Gondwanaland, and they were the ancestral immigrants of the present-day gymnosperm forests, the species of which form a major part of Cockayne's palaeozelandic element of the present flora.

The second flora developed during the Cretaceo-Oligocene, and it has to be remembered that in all probability New Zealand had no further continental connection after the Jurassic. There were instead various phases of elevation and sinking which produced alternately large and small island groups, the latter being ideal for speciation within the existing flora.

This second flora, which arose after a long lapse of time in the late Cretaceous, saw the entrance of deciduous dicotyledons, members of the Proteaceae and also the development of some of the more modern gymnosperms. Some of the ancestral forms of the present-day broadleaf species also arrived in New Zealand during this period, but the dominant forest vegetation appears to have been coniferous. At the end of this period a transitional flora, covering the Oligocene to middle Miocene, saw the entry of a number of important broadleaf families, including the Myrtaceae. There was also a decrease in the gymnosperm element. The second flora and this transitional flora yield therefore evidence of the entry of the ancestral broadleaf species, some of which today form the palaeotropic element of the present flora.

The third flora extended from the late Miocene to the Pliocene and was marked by the presence of present-day broadleaf genera. It is likely that this flora did not arise through any new mass immigration, but was in fact a gradual development from the early Cretaceo-Oligocene flora as a result of speciation associated with climatic and other environmental changes.

Changes since the Ice Age

The changes in the flora since the Quaternary ice age have been studied by means of pollen analysis. It has been found that there have been three distinct periods corresponding to similar periods in the northern hemisphere. The first period was cool, with the ice retreating, and the vegetation was dominated by grasses. This was succeeded by a middle warm period in which podocarps were dominant, and then there is the present period with a cooling climate and the podocarps replaced by species of *Nothofagus*, *Metrosideros* and grasses. The change of climate that initiated this last period took place about two to three thousand years ago.

It can be seen, then, that both the podocarp and broadleaf elements have existed in New Zealand for a very long time, and the predominance of one or the other has probably depended upon climatic changes, and, in the North Island, on the frequent development of new soils as a result of volcanic activity, the broadleaf species being generally intolerant of poor immature soil.

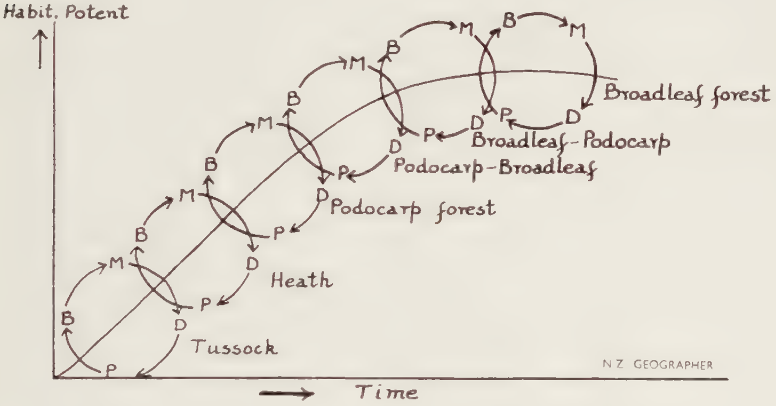

Fig. 5. Diagram to illustrate the possible build-up of habitat potential since glaciation in forest areas in New Zealand, and the succession of vegetation types. The cycles are based on 'pattern and process', and the sum total of all changes is shown by the hypothetical succession growth curve (P—pioneer phase; B—building phase; M—mature phase; D—degradation phase).

In 1926 Cockayne[14] first classed the lowland forest of New Zealand as subtropical rainforest. Earlier Schimper[15] had grouped these forests as warm temperate and comparable with the warm temperate forest of southern Japan and western Chile. Later he accepted Cockayne's viewpoint, and in 1935 the forests were classed as summer-moist subtropical forest.[16]

It can be argued today from the available meteorological data that the lowland forest climate is not subtropical, and it certainly cannot be regarded as summer moist; it is nearer winter moist. Using modern approaches to climatology, Kidson[17] and Garnier[18] have both shown that a rainforest climate exists mainly in the centre of the North Island, in Westland, and in the Waipoua area of Northland. Much of the forest, therefore, does not exist in a rainforest climate. It can be argued, however, that since there is no readily acceptable alternative term, the name 'rainforest' should be allowed to remain.

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[14] L. Cockayne: 'Monograph on the New Zealand Beech Forests', *State For. Bull. No. 4*, 1926.

[15] A. F. W. Schimper: *Plant Geography upon a Physiological Basis*, Oxford, 1903.

[16] A. F. W. Schimper und F. C. von Faber: *Pflanzengeographie auf physiologischer Grundlager*, Vols. 1 and 2, Jena, 1935.

[17] E. Kidson: 'The Elements of New Zealand Climate' in *N.Z. Weather and Climate*, N.Z. Geog. Soc. Spec. Pub., Misc. Series No. 1, 1950.

[18] B. J. Garnier: 'Thornthwaite's New System of Climate Classification in its Application to New Zealand', *Trans. Roy. Soc. N.Z.*, Vol. 79, Pt. 1, 1951, pp. 87-103.

Resemblance to Tropical Forest

If allowance is made for the anomalous climate, the problem still persists as to whether the forests are subtropical in status. Collectively there are features that give the forests a physiognomic resemblance to tropical forest. These features include cauliflory, the evergreen character of the leaves, buttress roots in maire *(Eugenia maire)*, lianes, abundant epiphytic mosses and ferns, and the presence of many phanerogamic epiphytes. Some of these characteristics, however, are more typical of tropical montane forest such as may be found in Indonesia, Borneo and Central Africa, where podocarps are also frequent. It is perhaps pertinent to note that Diels[19] as long ago as 1897 considered that the affinities lay with tropical montane forest. More detailed comparison, however, shows that these resemblances are more apparent than real. Furthermore, series C (*Fig.* 3) shows that an altitudinal gradient already exists in New Zealand comparable with the gradient found in the tropics. The New Zealand gradient can, in fact, be regarded as similar but, as it were, an octave lower.[20]

It must also be realised that it is really only the mixed podocarp-broadleaf and kauri forests which exhibit to the greatest extent a physiognomic resemblance to tropical forest. Pure podocarp and pure broadleaf forests possess only A and B tree strata, whereas the mixed and kauri forests have A, A_2 and B strata. If the evidence discussed earlier in favour of the historical origin of the mixed forests is accepted, then clearly there is no real affinity with tropical or subtropical forest. This, however, possibly does not apply to the kauri forest.

Oceanic Aspects

Furthermore, when the floristics of the forest are considered in detail, certain pertinent facts emerge. The first is that the lianes and epiphytes, regarded as a subtropical feature, belong mostly to families other than those found as lianes and epiphytes in the tropics. It is in fact a case of parallelism rather than of affinity. Second, there is the so-called Malayan element of the New Zealand forest flora. When this is analysed in detail, however, it is found that there is a far greater affinity, both floristically and ecologically, with the flora of the Pacific islands. Thus the following so-called Malayan genera found in New Zealand are common throughout the Pacific islands: *Litsea*, *Pittosporum*, *Melicope*, *Weinmannia*, *Elaeocarpus*, *Dysoxylum*, *Metrosideros*, *Myrsine*, *Nothopanax*, *Geniostoma*, *Myoporum* and *Freycinetia*. There are also a number of forest-tree genera confined in distribution to the Pacific islands and not found in Malaya, for example, *Paratrophis*, *Hedycarya*, *Corynocarpus*, *Knightia*, *Melicytus*, *Pennantia*, *Alectryon*, *Coprosma*, *Ascarina*, *Macropiper* and *Rhopalostylis*. The New Zealand lowland forest thus has a strong oceanic aspect, and with increasing knowledge of the ecology of the forests of Fiji, Samoa, Tonga and New Caledonia it is becoming evident that New Zealand affinities lie more closely with these Pacific islands.

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[19] L. Diels: 'Vegetations-Biologie von Neuseeland', *Englers Bot. Jahrb.*, Vol. 22, 1897, p. 202.
[20] Robbins: *op. cit.*

CONTINENTAL AND ISLANDIC COMPONENTS

The lowland forest, other than kauri forest, may then be regarded as possessing two components, one continental, the other islandic. The continental component is represented by the palaeozelandic gymnosperm element together with the subantarctic–South American angiosperm genera such as *Laurelia*, *Griselinia*, *Pseudopanax*, *Aristotelia*, *Fuchsia* and *Pseudowintera*. The island component is represented by the broadleaf forest element consisting of the genera that migrated from the Pacific islands. Robbins has suggested that this migration may well have taken place from Merrill's second centre of Pacific dispersal, ancient Papualand.[21]

It would seem then that Cockayne's and Schimper's view of the New Zealand lowland forest (except kauri forest) as subtropical cannot be substantiated, although the broadleaf forest consists of species whose relations are subtropical and tropical. The species themselves have evolved under a climate that has mostly been warm termperate.

The present author has previously suggested that the New Zealand forests can perhaps best be classified by the application of Rübel's system.[22] The forests here are divided into, among others, rainforest of the tropics and subtropics (Pluviisilvae) and laurel-leaf forest

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[21] E. D. Merrill: 'Malaysian Phytogeography in relation to the Polynesian Flora' in *Essays in Geobotany*, Berkeley, 1936, pp. 247–262.

[22] E. Rübel: *Die Pflanzengesellschaften der Erde*, Bern, 1930.

(Laurisilvae). It has been indicated that the kauri forests of northern New Zealand exhibit features that distinguish them from the other lowland forests. Arguments can indeed be adduced to suggest that these forests represent relics of the only subtropical forest in the country. Even here, however, further work is greatly to be desired. According to Rübel the Laurisilvae are characteristic of winter-moist regions with generally warm temperatures. Two types of Laurisilvae are recognised, one dominated by broadleaf (laurel-leaf) species and another, the gymnosperm/laurel-leaf forests, in which the gymnosperms are commonly represented by podocarps. On the basis of all the information available it would seem that the pure podocarp, pure broadleaf and mixed podocarp–broadleaf lowland forests of New Zealand should all be grouped as gymnosperm/laurel-leaf forests within the Laurisilvae, and one could then properly term these forests the warm temperate Pacific Laurisilvae, or even more simply, the southern Laurisilvae.

THE AGRICULTURAL LIME INDUSTRY OF THE SOUTH ISLAND

L. J. KING

THE ESTABLISHMENT and maintenance of high-producing pastures is vital to the economic wellbeing of New Zealand. Lime, as a most important agent in neutralising soil acidity and in making available plant nutrients in the soil, has thereby assumed a vital role in farm practice. Nearly two million tons are applied annually to the soils of New Zealand, and more than sixty percent of this tonnage is manufactured and used in the South Island.

Growth of the Industry

The production of agricultural lime in the South Island began as early as 1880 with the establishment of a small lime kiln at Milburn in South Otago. The growth of the industry was intimately linked with the expansion of pastoral farming throughout the South Island following the introduction of refrigeration. Heavy cropping for grain in many lowland areas had seriously depleted soil fertility and the successful establishment of good pastures called for at least a partial restoration of fertility.

The beneficial results of applying limestone to the soil had long been recognised in the United Kingdom and the United States.[1] In 1890 the Australian and New Zealand Land Company began an extensive liming experiment on two hundred acres of its Edendale estate in Southland, and established the precedent for what has become an integral part of farming practice throughout most of the country. On the plains of Southland the comparatively heavy annual rainfall of fifty to sixty inches resulted in more severe leaching of the soil than in the drier districts of the eastern South Island. Heavy applications of lime, sometimes as much as six tons per acre, were found necessary, and as early as 1900 Southland was already the leading lime-producing district in New Zealand. At first, the limestone was 'burnt' in stone kilns about twenty feet high and ten feet in diameter (*Fig.* 1), but early this century there were experiments in the use of unburnt, crushed limestone which could be produced in far larger quantities and more

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[1] W. D. Hunt: 'Lime and Liming in Southland,' *N.Z. Journ. Agric.*, Vol. 13, No. 2, 1916, pp. 87-96.

Fig. 1. Old stone limekiln at Sandymount, Otago Peninsula. This kiln was in use until 1939, the lime being used mainly for industrial purposes. The quarry face is in the background.

cheaply.[2] By 1935 there were sixteen crushing mills in operation in the South Island, nearly half of them in Southland.

During the second World War the production of agricultural lime was increased to meet the heavy demands on soil resources. The effects of the stimulus were again most pronounced in Southland where four large new limeworks were established between 1940 and 1946, increasing the district production to the equivalent of nearly one third of the New Zealand output and to more than one half of that of the South Island. Elsewhere in the South Island development of the lime industry was not spectacular until the postwar decade 1945-1955. Although for some years the use of lime on the light shingle soils of Otago, Canterbury and Marlborough had been advocated, application lagged until 1947 when the government transport subsidy on lime was extended to cover road haulage as well as that by rail. Moreover, the new larger limeworks established in the postwar period were able to take advantage of improved methods in the quarrying, handling and spreading of lime.

LOCATION OF LIMEWORKS

In 1955 more than seventy limeworks contributed to the total lime production of 1,004,000 tons in the South Island. Although these limeworks were apparently widely scattered (*Fig.* 2), the bulk of the production was concentrated in four areas—in the vicinity of Winton

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[2] For every ton of burnt lime produced, at least one and three quarter tons of rock, and over a third of a ton of fuel had to be handled. See P. G. Morgan: 'The Limestone Resources of New Zealand,' *N.Z. Geol. Surv. Bull.*, Vol. 22, 1919, p. 228.

(Southland), Oamaru (North Otago), Cave (South Canterbury) and Cheviot-Waikari (North Canterbury). To facilitate regional analysis, five lime-producing districts have been delineated in Figure 3. Southland is the most clearly defined and by far the most important. Its twelve full-time plants grouped within a thirty-mile radius of Winton produced thirty-eight percent of the South Island output in 1955. By contrast, the Nelson–West Coast district with six small and widely-scattered limeworks produced a little more than three percent of the total. The Otago district with only six limeworks ranked second in production with twenty-two percent of the total. The South Canterbury and the North Canterbury-Marlborough districts, both containing twice as many plants as did Otago, produced only nineteen and eighteen percent respectively (Table I).

TABLE I

LIME PRODUCTION BY DISTRICTS, 1955*

District	No. of Lime-works	Total Production†	Average No. of Men per Plant	Average Production per Man††
Southland	12	379	9.4	3,356
Otago	6	224	7.3	5,105
South Canterbury	13	191	3.7	3,972
North Canterbury–Marlborough	14	176	3.6	3,497
Nelson–West Coast	6	34	5.0	1,149

*Limeworks for which statistics were available; part-time plants are not included (Source: Department of Statistics, Wellington). † Thousands of tons. †† Tons.

TABLE II

SIZE OF LIMEWORKS OPERATING IN 1955

Size of Unit and Output	Number of Plants	Total Tonnage of Group	Percentage of South Island Output
Small; less than 10,000 tons	24	131,531	13.1
Medium; 10,000 to 40,000 tons	21	433,487	43.3
Large; over 40,000 tons	6	438,960	43.6

Although small-sized plants, each producing less than 10,000 tons annually, were the most numerous in the South Island in 1955, medium-sized and large limeworks accounted for the bulk of the output (Table II). Six large works produced more than two-fifths of the total output.

The size of plant and the relative importance of each size group varies considerably from district to district. In Southland and Otago, particularly, large limeworks account for most of the production whilst in the other three districts the medium-sized and small works are the more important (Table III).

TABLE III

SIZE OF LIMEWORKS BY DISTRICTS, 1955

District	Number of plants			Percentage of District Output		
	Small	*Medium*	*Large*	*Small*	*Medium*	*Large*
Southland	2	7	3	4	43	53
Otago	3	1	2	6	9	85
South Canterbury	6	6	1	21	55	24
North Canterbury–Marlborough	7	6	–	26	74	–
Nelson–West Coast	5	1	–	58	42	–

By far the greater number of limeworks is owned by registered companies in which local farmers are the main shareholders. There are, however, certain regional peculiarities in the source of capital investment and the type of ownership. In Southland two plants

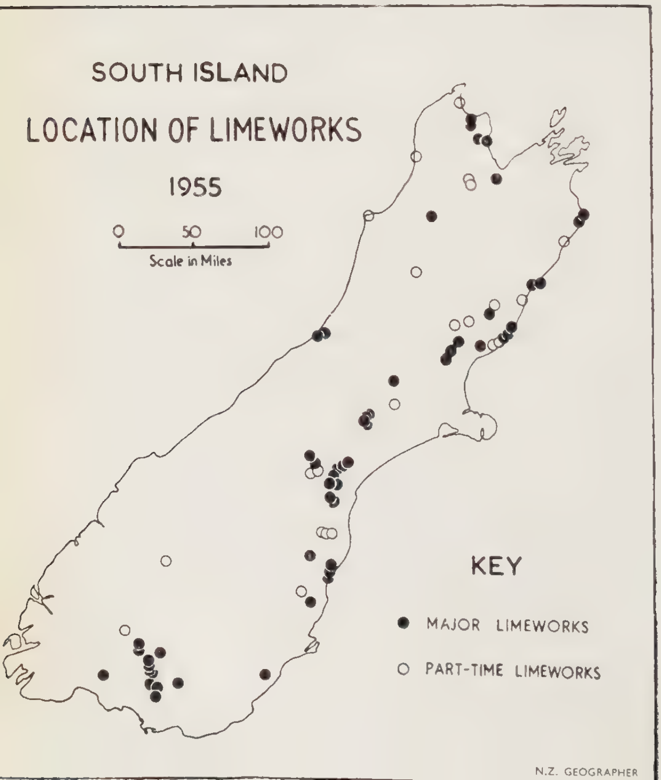

Fig. 2. The location of limeworks in the South Island of New Zealand

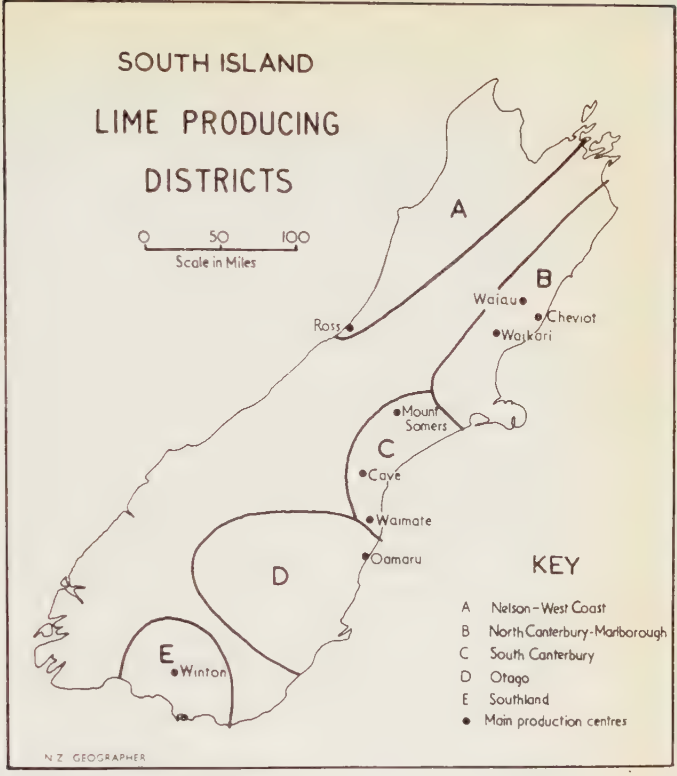

Fig. 3. Lime-producing districts of the South Island, New Zealand

operate as subsidiary companies of stock and station agencies, whilst at Motueka, Kaikoura and Cheviot, and in South Canterbury, large transport agencies have made considerable financial investments in the lime companies. In North Canterbury and the lakes district of western Otago there is a number of very small part-time limeworks owned by farmers and operated intermittently by mobile crushing plants.

THE RESOURCE BASE

A high standard of purity is not essential in limestone which is to be crushed for agricultural use, but the development of the industry in the South Island has been facilitated by the widespread occurrence of limestones which seldom average less than sixty-five percent of calcium carbonate and are often as pure as ninety-eight percent. (See Figure 4.)

Throughout Southland there are numerous outcrops of a clay-brown, highly-fossiliferous limestone which averages between seventy and eighty percent of calcium carbonate. The most important outcrop being worked lies east and northeast of Winton, although it is by no means as extensive as the Waiau Valley formations in western Southland. Smaller quantities of lime are quarried from two small outliers northwest of Dipton, from a narrow strip along the southwestern side of the Waimea Plain, and from the fringe of the Hokonui Hills west of Gore and Mataura.

Although of reasonably high quality, Southland limestones are by no means as pure as those which outcrop in prominent escarpments to the west of Oamaru in Otago. The Oamaru limestones are of a greyish-cream colour and fairly soft, and are of an exceptionally high purity. The formations dip at a very shallow angle and make possible the use of extremely efficient quarrying methods. Other quarries in Otago work outcrops in the Waitaki Valley,[3] the hard laminated Milburn limestone in South Otago, the very hard crystalline limestone at Dunback, and several small pockets in the western lakes district.

Unlimited supplies of high-grade limestones occur in the downlands of South Canterbury. In appearance these are similar to the Oamaru formations but are of somewhat lower purity, varying from seventy to eighty-five percent of calcium carbonate. Limestone of commercial value also outcrops near Mount Somers, although the presence of interbedded layers of volcanic ash and tuff has created problems for quarry operators.

Through North Canterbury and Marlborough the predominant limestone is the glistening-white, high-quality Amuri limestone, although in the Waikari district several quarries work the Mount Brown formation which is similar in colour and composition to the Southland outcrops. The Nelson–West Coast district, although not a major producer of agricultural lime, contains widely distributed outcrops of high-grade stone. These include the very old, dark bluish-grey Maitai limestones which occur in a narrow belt from D'Urville Island to Lake Rotoiti, the hard, but exceptionally pure marble on the summit of the Pikikiruna Range, and the softer Tertiary limestones of Northwest Nelson and the West Coast. The small local demand and the inaccessibility of many of the outcrops has resulted in only very limited commercial development of the limestone resources of this district.

Labour Problems

There were approximately 285 persons employed in the South Island lime industry in 1955. The maintenance of this labour force has been one of the industry's most pressing problems. The dusty, unattractive working conditions have failed to draw young men to the limeworks, and it has been difficult to replace older workers. The markedly seasonal demand for lime accentuates the employment problem and the majority of smaller plants close during the winter. The two peak periods of demand occur between September and December, when crops and pastures are being sown, and in May when pasture top-dressing is at a peak. However, recent technical developments, especially in quarrying, have brought partial relief to the labour problem. Whereas in the older Southland plants five or six men are required in the quarries, the more recently-established limeworks of Canterbury and Otago achieve a comparable production with only one or two men in the quarries.

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[3] G. H. Uttley: 'Tertiary Geology of the Area between the Otiake River and Duntroon, North Otago,' *Trans. N.Z. Inst.*, Vol. 52, 1920, pp. 137-153.

The figures for the average productivity of labour per plant shown in Table I serve to emphasise the undeveloped nature of the industry in the Nelson–West Coast district, and the generally efficient organisation in Otago, South Canterbury and North Canterbury, and suggest the need for reorganisation of many of the older Southland limeworks.

FACTORS IN PLANT LOCATION

The marked correlation between the pattern of distribution of limeworks and the location of the most important limestone formations suggests that the industry is tied to the source of its raw material.

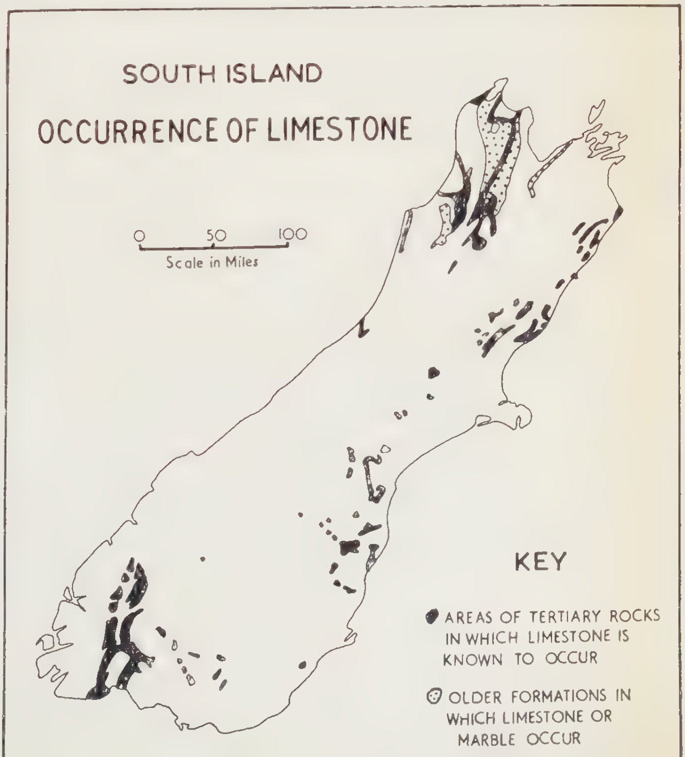
SOUTH ISLAND
OCCURRENCE OF LIMESTONE
0 50 100
Scale in Miles
KEY
● AREAS OF TERTIARY ROCKS IN WHICH LIMESTONE IS KNOWN TO OCCUR
○ OLDER FORMATIONS IN WHICH LIMESTONE OR MARBLE OCCUR

Fig. 4. Occurrence of limestone in the South Island of New Zealand

Limestone, a bulky material with a very low value per unit of weight, is economically unsuited to long transport hauls. The availability of reasonably high quality limestone which could be economically quarried and processed has therefore been a basic factor in the location of the industry. Nevertheless there remain extensive outcrops of limestone of high quality which have had little or no commercial development. (See Figure 4.) It is the existence of a good local market for lime that has determined the particular formations to be utilised. Thus the four heaviest concentrations of the industry occur in the intensive pastoral farming areas of Southland, North Otago—more particularly the Waitaki lowland—and the downlands of South and North Canterbury.

Government subsidies on the transport of lime have had an influence on plant location in fostering a wide dispersal of the industry. Subsidies have never applied on hauls of more than one hundred miles for rail transport and thirty miles for road haulage, thus checking any tendency for one district to monopolise production. Similarly the availability of transport facilities has been important in influencing the choice of site for the processing plant. Before 1948 many companies took advantage of the free railage concession by siting their plants alongside the railway and at some distance from the quarry, and in one instance a crushing plant was erected near a railway station about five miles from the quarry. Since 1948 the greater mobility of motor transport has allowed much more emphasis to be given to the choice of a suitable quarry in the location of a limeworks, and the present development of road transport threatens to render uneconomic many of the present railway sites.

THE MANUFACTURING PROCESS

Two main methods of quarrying are employed. For many years blasting with dynamite was the only method in use, and even today, in areas of hard crystalline limestone, it is the only practicable technique. However, early in the 1940's, an Oamaru lime company began ploughing or 'rooting' limestone by the use of a set of heavy steel tines drawn by a high-powered bulldozer. Subsequent trials have shown that the majority of the Tertiary limestone formations of the South Island can be quarried in this way, and in the past ten years the practice has been widely adopted, most recently in Southland. Whereas blasting involves working from a steep quarry face which is progressively cut back, rooting is carried out on a flat or rolling surface from which horizontal layers of limestone are removed. Not only does the use of a 'root' cut down the number of men required in a quarry by one half, but the limestone is much finer than when it is blasted and it can be processed at a faster rate.

The quarried limestone is first crushed into small fragments of four to six inches in diameter by the primary crusher which is sited as near to the quarry as possible, usually on the downhill slope below the quarry edge. A belt conveyor then moves the rock into the main plant where it is finely pulverised, screened and then stored in large bins which are elevated to allow motor lorries or railway waggons to load beneath. In Southland, Otago and South Canterbury it is common to dry the lime in long revolving cylinders before pulverising. This was found necessary in Southland because of the high rainfall and the very absorbent nature of the stone. Although these considerations do not apply to the same extent in Otago and South Canterbury, experience has shown that artificial drying enables production to be maintained at a consistently high level, whereas a wet spell often forces the producer of undried lime to cease operations temporarily. However, heavier pulverising machinery and new types of spreading vehicles are making artificial drying unnecessary in some districts, and several limeworks in North Canterbury–Marlborough formerly operated drying kilns which are now idle, and three plants in Southland are now successfully producing undried lime.

DISTRIBUTION

The relative significance of rail transport has declined steadily over the past ten years, and whereas in 1949 sixty-six percent of the production was distributed by rail, only thirty-one percent of the South Island output was railed in 1955. In 1947 the government subsidy on lime transport was extended to cover road haulage and heralded the appearance on New Zealand country roads of the bulk-spreading motor vehicle capable of loading five to six tons at a limeworks and moving directly into the field on which the lime is to be spread.

In spite of the preponderance of road haulage, large quantities of lime are still railed outwards from Oamaru, Winton and North Canterbury stations (*Fig.* 5). Over 150,000 tons of lime were railed in 1955 from Oamaru to stations as far distant as eastern Southland and mid-Canterbury. A further 70,000 tons were railed from Winton to the farming districts of Southland, while from North Canterbury stations 65,000 tons were despatched, mainly to mid-Canterbury, but a small tonnage went to the West Coast. A characteristic landscape feature in the lime-consuming districts is the stockpile of up to five thousand tons which has been built up in the railway yards during the winter. Local cartage contractors can then obtain supplies quickly at periods of peak demand.

The haulage of lime by road and its spreading on farms is in the hands of more than 150 small general carriers, each of whom operates one, two, or possibly three, bulk-spreading vehicles in addition to general-purpose lorries. Since the government subsidy is payable only on the first thirty miles of any road haul, the small local operator is encouraged. Moreover the markedly seasonal demand favours the general carrier rather than the contractor concerned exclusively with the transport and spreading of lime.

Aerial spreading of lime is comparatively unimportant because of the high cost, but lime mixed with superphosphate is often dealt with in this way. Most of the intensive-farming areas in the South Island can in fact be limed by using motor vehicles. Furthermore, experiments in the North Island and in North Canterbury with the use of a high-powered fan mounted on a bulk-spreading vehicle have shown that liming of fairly broken country by surface methods is possible.

Lime-Producing Districts: Southland

Considerable diversity is apparent among the five lime-producing districts of the South Island in the nature of the limestone, in the volume and methods of production, in the size and organisation of the lime-works and in the general efficiency with which production is achieved. These diversities may now be summarised in a brief consideration of each of the five districts.

In Southland, although many of the works contain some very old plant, and although average production per man is comparatively low, the district stands foremost in the production of lime, not only in the South Island but indeed in New Zealand. The lime industry contributes significantly to the rural landscape, especially on the Oreti Plain where numerous yellow-brown quarry faces stand out as prominent gashes on ridges and knolls which border the plain or outcrop above its surface. On flat ground below the quarry and alongside the railway are large limeworks connected to quarries by characteristic long conveyor belts.

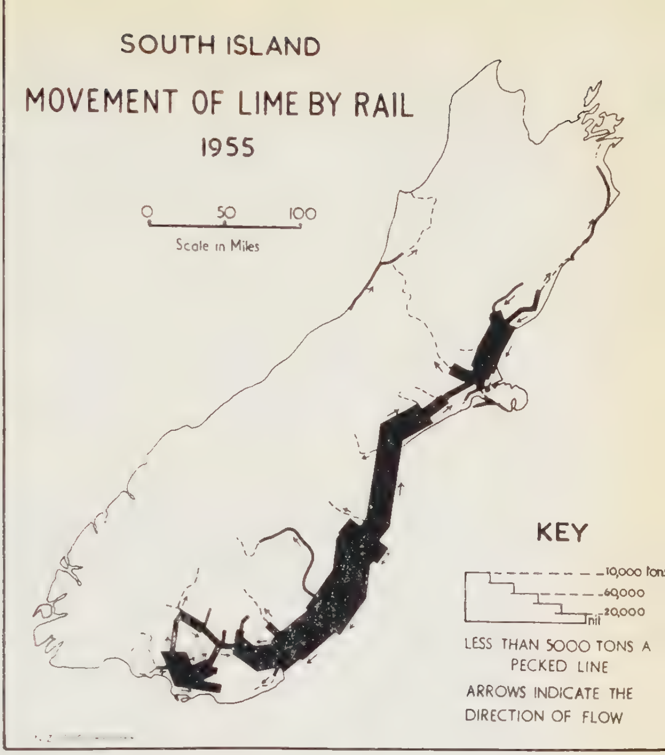

Fig. 5. Movement of lime by rail during 1955 in the South Island of New Zealand

Note: In the key the figure 10,000 should be 100,000.

The enclosed conveyor belts reflect not only the past importance of rail transport as a factor in the siting of the crushing plant, but also the need for sheltering the very porous Southland limestones from the weather. Hovering clouds of smoke and dust, and bulk-spreading vehicles trailing long billowing clouds of dust, are features which are seen also in other districts, but in no other part of the South Island do they reflect such an extreme 'lime-consciousness' on the part of the farming community as they do in Southland.

OTAGO AND SOUTH CANTERBURY

There are only six limeworks in the Otago district, and by far the most important are the two large plants near Oamaru which produced over eighty-five percent of the district output in 1955. (See Figure 6.) Of the remaining four plants, three quarry limestone for industrial rather than for agricultural use. At Dunback and Milburn, for example, production is mainly for the cement industry. Although Otago limestones are not as uniform in character as those of Southland they are of much higher purity.

In the heart of the South Canterbury district are eleven limeworks in the downlands within a radius of twenty-five miles from Cave.

All these plants are of small or medium size. Two secondary centres of production are situated at Waimate and at Mount Somers in mid-Canterbury. At Mount Somers layers of volcanic ash and tuff are interbedded with the limestone, but selective quarrying and artificial drying of the stone have overcome these difficulties, and the locality has the only large-sized limeworks in the South Canterbury district. The industry in South Canterbury is young, and its recency of growth is reflected in the widespread use of the most modern techniques and equipment and in the almost complete reliance on road transport for the movement of lime. The equipment for quarrying by rooting requires a heavy initial capital outlay which many of the smaller companies are unable to obtain; therefore a Timaru contractor at present visits some of these works in turn. Contract quarrying is unique to this district, although for smaller plants it appears to be a most economical procedure.

Fig. 6. Limeworks near Oamaru. This works has the largest output in New Zealand, the limestone being 'rooted'.

NORTH CANTERBURY-MARLBOROUGH

The heavy demand for lime which has arisen in the North Canterbury downlands and adjoining plains since the war has resulted in a concentration of seven limeworks and nine part-time units within the area bounded by the townships of Waiau, Cheviot and Waikari. Medium-sized plants producing 20,000 to 25,000 tons annually are predominant, but the numerous part-time works are noteworthy. (See Figure 7.) The majority of these are merely pits owned by local farmers and worked from time to time by a mobile crushing unit under contract from one of the full-time works. Throughout Marlborough, rugged terrain and poor transport facilities have restricted the use of lime, and the small and scattered plants are more typical of those found in Nelson–West Coast. However, a marked similarity in the type of stone—the white compact Amuri limestone—and in the production techniques employed justifies the grouping with North Canterbury. Rooting is practised in only two localities, Cheviot and Waikari, and with one exception all plants in the district produce undried lime—a marked contrast to the three southern districts. Rail transport is still important, and the majority of works are sited alongside the railway or have subsidiary bins at railway sidings.

Fig. 7. A small, part-time unit characteristic of South Canterbury and North Canterbury–Marlborough districts

Nelson–West Coast

Small ventures, frequently unsuccessful, have characterised the development of the lime industry in the Nelson-West Coast district. Yet the stone which has been worked is of a high quality, many formations containing over ninety percent of calcium carbonate. Difficulties of access to outcrops and the small size of plant have made for the highest production costs in the South Island. These, together with high transport charges, have kept the demand for lime at a low level despite the obvious success achieved by liming pastures in this high-rainfall district. Only in the past five years has there been appreciable extension of plant capacity, and this chiefly as a result of investment by transport companies rather than by farmer-shareholders.

THE FUTURE

The demand for agricultural lime has been steadily increasing throughout the South Island and the future of the industry appears bright. Should the present rate of increase continue, the 1955 output of approximately one million tons could well be doubled within the next decade. Whether the present high level of demand can be maintained or increased will depend on the continuation of the already heavy liming programmes in the intensive-farming areas, together with the more widespread use of lime in the reclamation and improvement of marginal land. Reclamation, for example, of the Moutere Hill scrublands in Nelson,[4] of the river flats and low terraces on the West Coast, and of the extensive areas of 'browntop country' in Canterbury, Otago and Southland calls for the widespread use of lime in large quantities.[5] On the other hand in many of the older farming districts, particularly Southland, the problem of excessive liming has been recognised. Trial studies by the Department of Agriculture suggested that on certain acid-type soils in Otago and Southland the application of as little as two ounces of molybdenum per acre produced as marked an improvement in pasture growth as was commonly obtained by dressings of many tons of lime per acre. Publication of these results led to a considerable decrease in the demand for lime in 1953. However, the decline was short-lived and it now appears certain that trace elements can never entirely replace lime, although their use in the future may substantially reduce the amount of lime required.

It is probable that the greater part of any increase in future production will be met by existing limeworks, although some expansion of present plant capacity will be required. Already many of the larger works are carrying out improvements to ensure, first, economical quarrying and transport of the quarried stone; second, faster movement of the raw material through the processing stages by the installation of more powerful machines and by improved plant layout; and third, the provision of ample storage space. Undoubtedly some new limeworks will be opened, but it is most likely that such plants will be small, possibly part-time, units.

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[4] R. H. Scott: 'Land Development in the Nelson District,' *N.Z. Journ. Agric.*, Vol. 91, No. 1, July 1955, pp. 2-12.

[5] J. R. Shepherd: 'Improvement of Ploughable Pastures in Westland,' *ibid.*, Vol. 88, No. 4, April 1954, pp. 337-340; and A. Stuart: 'Development of Browntop Country in the South Island,' *ibid.*, Vol. 86, No. 2, February 1953, pp. 155-163.

It was noted earlier that the six largest limeworks at present produce some forty-three percent of the South Island output. Table IV indicates that some of these large limeworks can produce at an exceptionally low cost compared with some smaller units. It seems pertinent therefore to consider whether lime production will eventually be concentrated at a few large works located some distance apart, or whether it will continue in the hands of many companies of varying size distributed widely throughout the island.

TABLE IV

AVERAGE COST OF PRODUCTION, 1955

Limeworks	Approximate Annual Tonnage	Average Cost per Ton
Small Unit, Nelson–West Coast	3,500	£2.03
Small Unit, North Canterbury–Marlborough	9,000	£1.00
Medium Unit, South Canterbury	17,000	£0.38
Medium Unit, North Canterbury–Marlborough	30,000	£0.57
Large Unit, Southland	90,000	£0.57
Large Unit, Otago	120,000	£0.35

Notwithstanding their generally low production costs, the large limeworks have in fact been declining in relative importance over the past decade. Whereas in 1945 they produced nearly sixty percent of the total output, they produced only fifty-one percent in 1950, and forty-three percent in 1955. Correspondingly, there was a marked increase in the importance of many small and medium-sized plants. At present the majority of the small works are burdened by high production costs and might be the first to suffer from the effects of falling prices for farm produce. But it has been shown by one plant in South Canterbury that large-scale organisation is not essential for cheap production of lime. With an annual output of about 17,000 tons this plant has the second lowest production costs in the South Island. While it appears likely that in Southland, Otago and South Canterbury the large limeworks will continue to dominate, it is equally clear that the medium-sized and small plants will continue to play an important role, especially in North Canterbury, Marlborough, Nelson and the West Coast.

CONCLUSION

The future of the agricultural-lime industry in the South Island depends on the level of demand from the farming community. The temporary setback to production in 1953 suggests that the demand may be fairly elastic, and that with increased knowledge of trace elements and with any appreciable fall in farm incomes, the quantity of lime required may fall considerably. Nevertheless, in 1955, lime production was an expanding and vigorous industry, displaying wide diversity in its pattern of distribution, resource base, organisation and structure, and, as such, contributed to the geographic variety of the South Island.

A CENTURY OF HUMAN INFLUENCE ON HIGH COUNTRY VEGETATION

D. H. RELPH

HOW FAR the vegetation of the South Island High Country has been modified by man has been a controversial question in recent years. The answer is of considerable importance in determining future management practices. This article, therefore, is an attempt to analyse the extent to which the vegetation has been modified, and to reconstruct its pre-European condition, in a representative area of the Canterbury High Country. The area examined, the Castle Hill Basin[1] in the Waimakariri Valley, covers only eighty square miles and is slightly higher and drier than much of the surrounding country. Nevertheless it is considered to be sufficiently representative for conclusions to be reached which are reasonably applicable to much of the Canterbury High Country.

Although the present-day vegetation of the Castle Hill Basin is predominantly indigenous, most of the communities have been considerably altered in species composition, in distribution, and, to some extent, in physiognomy. The pre-European vegetation has been constantly under the influence of man since the Flock Hill run was taken up by J. Hawdon in 1857, and that of Castle Hill by the Porter brothers in 1858. Before this time, Maoris had used part of the area as a halting place on journeys to the West Coast, but it is doubtful if they disturbed the vegetation to any extent.

EVIDENCE OF EARLY PHOTOGRAPHS

It is obviously impossible accurately to reconstruct the pre-European vegetation after a hundred years of settlement. However, some attempt can be made, first by examining the factors which have been responsible for modifying the vegetation, and then, with the aid of the conclusions reached and with the examination of early descriptions and photographs, estimating in greater detail the character of the pre-European vegetation communities and their distribution within the Castle Hill Basin.

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[1] A more detailed account of the general features and of the present-day vegetation is contained in D. H. Relph: 'The Vegetation Cover of the Castle Hill Basin', *N.Z. Geographer*, Vol. 13, No. 1, April 1957, pp. 41-55.

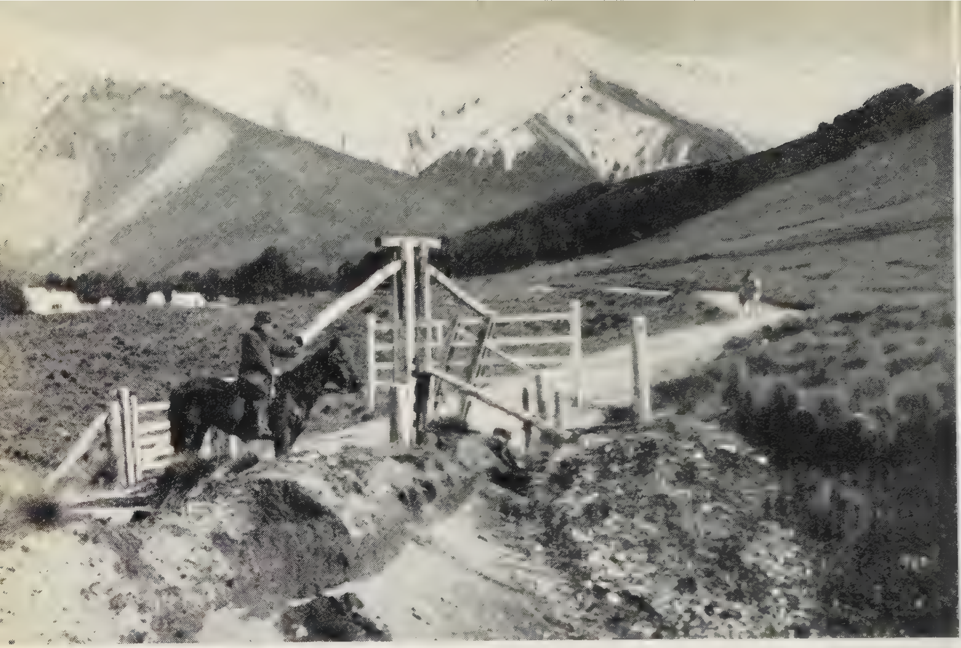

Fig. 1. Photograph, taken in 1882, looking towards the old Enys homestead, with Long Spur and the Craigieburn Range in the background. Exotic grasses are not evident among the tussocks. The gate was designed for use in deep snow.

The most accurate information can be gained from the examination of early photographs. A number of these are available, illustrating the state of the vegetation after less than twenty-five years of occupance.[2] These photographs, some of which are illustrated in Figures 1 to 4, reveal several features. Although the mountains are not shown clearly enough to indicate the actual density of the vegetation, the photographs do demonstrate that, in general, the vegetation cover does not appear to have been much more extensive in 1882 than it is at present. The foregrounds of the photographs reveal that the tussocks were generally closer, but the intervening spaces appear to be barer because exotic grasses had not reached the area by that time, although some exotic weed species were present. Most noticeable is the fact that scrub was much less frequent than it is today. Photographs taken in 1868 also illustrate what appears to be burnt manuka, and the tussocks are very stunted—possibly as a result of burning.

Of the factors which have been responsible for modifying the vegetation, the most important are the effects of burning, grazing by both stock and introduced animal pests, and the planned and chance introduction of exotic plants.

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[2] The most valuable sources include two albums of photographs in the Canterbury Museum; E. Dobson: *New Zealand Views*, 1868, Nos. 14 and 15; and Burton Bros: Unpublished album, [1882], Nos. 1513 to 1536.

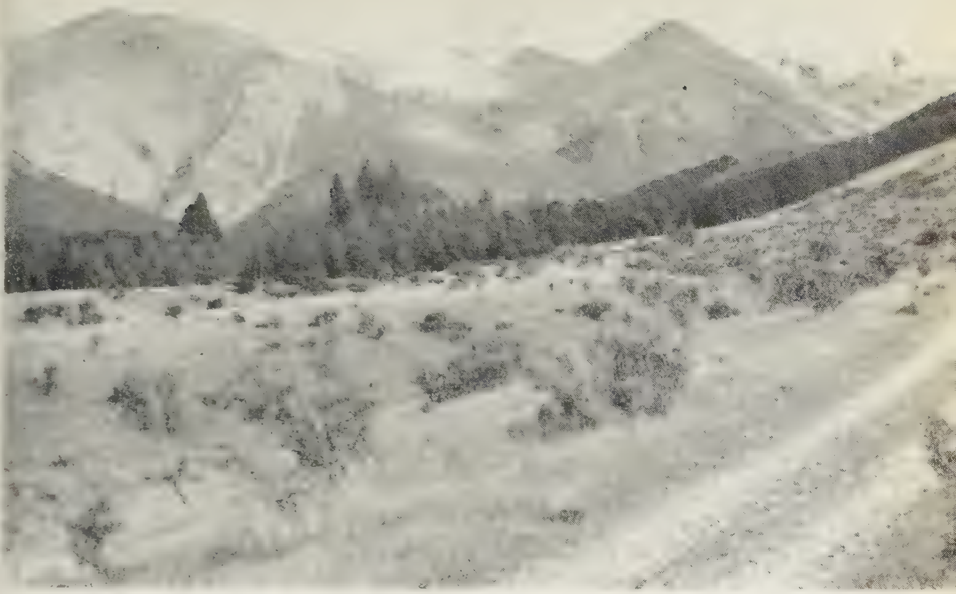

Fig. 2. Photograph, taken in 1953, from the same spot as in Figure 1. Exotic grasses now almost mask the tussocks; matagouri and taihinu scrub is widespread; and planted and self-sown larches are thriving. There is evidence of accelerated erosion on Long Spur.

EFFECTS OF BURNING

The first entry of Europeans into the area, in 1857, was recorded by Acland:[3]

> He [J. Hawdon] sent Pearson up the Waimakariri to explore. According to the custom of those days, Pearson burnt the country as he went, and although he was away longer than they expected, Hawdon could see from the plains the smoke of his fires in the upper Waimakariri and knew that he was at work. When he returned, Hawdon applied for the country on his recommendation.

It is probable that much of the Castle Hill Basin was subjected to this fire, and its effect on the grassland, which had accumulated a mat of decaying vegetation over a long period, must have been disastrous. Thus, the first impact of man appears to have been by means of fire, and it is certain that severe and frequent burning continued to be a normal management practice for several decades. In recent years this has become less important, and the Castle Hill run has not been burned since 1929, nor Flock Hill since 1951.

The widespread, and often indiscriminately-lit, fires of the early years of settlement were aimed first at the destruction of speargrass (*Aciphylla* spp.), manuka, matagouri and other scrub, so as to increase

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[3] L. G. D. Acland: *Early Canterbury Runs*, Christchurch, 1946, p. 216.

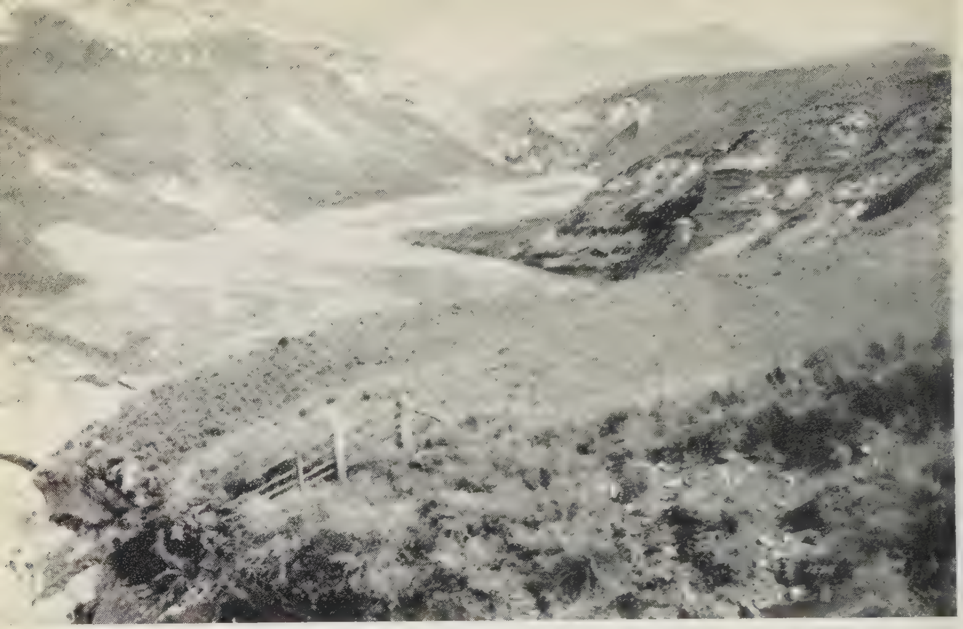

Fig. 3. Photograph, taken in 1882, looking up the Porter River, with Prebble Hill on the left. The riverbed carries stable vegetation.

accessibility. As early as 1863, Samuel Butler[4] stated that burning was essential:

> The fire dries up the swamps—at least many disappear after country has been once or twice burnt; the water moves more freely, unimpeded by the tangled and decaying vegetation which accumulated round it during the lapse of centuries, and the sun gets freer access to the ground.

This opening-up of the grasslands aided the rapid establishment of scrub communities, particularly in the wetter parts. Manuka and taihinu (*Cassinia fulvida*) were particularly successful invaders as Figures 1 and 2 illustrate.

It was soon found that the young growth, which appears after the burning of the tussocks, was more palatable, and consequently the grasslands were burned to increase the amount of feed available. However, as a result of this burning, the dominant fescue tussocks (*Festuca novaezelandiae*) were weakened and reduced in size and number. The drier, sunnier and steeper faces were most seriously affected in this way, for often new growth came only from the edges of the tussocks, and in most cases no seed heads were produced. On the other hand, the denser and smaller blue tussock (*Poa colensoi*) is less susceptible to burning, and so tended to increase at the expense of the fescue tussock.

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[4] S. Butler: *A First Year in the Canterbury Settlement*, London, 1863, p. 54.

Fig. 4. Photograph, taken in 1953, of the same area. Exotic grasses are now abundant, and shingle dominates the riverbed.

With the decrease in the tussocks and the destruction of the protective and humus-forming mantle of decaying leaves, the milder microclimate of the intertussock spaces was partially destroyed. Thus, the minor and more palatable species were subjected to harsher environmental conditions, and the seeds, already reduced in quantity by fire, were less able to establish themselves. Moreover grazing animals had greater access to the intertussock species and to the young growth of the tussocks themselves.

Along with the destruction of species susceptible to fire came an increase in the less palatable and the more fire-resistant species. The more open cover proved particularly favourable for the entry of small mat-forming herbs such as *Leucopogon fraseri*, *Raoulia subsericea*, *Pimelia prostrata* and species of *Acaena*. Twitch grasses were better able to survive because of their creeping habit, and the opening-up of the grassland also allowed free-seeding exotic species to enter, especially grasses with a twitch-like habit such as browntop (*Agrostis tenuis*) and sweet vernal (*Anthoxanthum odoratum*). Exotic 'weed' species such as sorrel (*Rumex acetosella*) and catsear (*Hypochaeris radicata*) were able to establish themselves readily on the patches of bared ground. It was at higher altitudes that fire was most destructive. Tall tussocks are particularly susceptible to fire, and so with the destruction of a single tussock a large area was exposed and a large amount of very slowly decaying vegetation was destroyed. The spongy, water-retentive habit of *Celmisia spectabilis* allowed it to resist burning and to increase at higher altitudes, while other celmisias such as *C. lyallii*, which have not this habit, were reduced by fire. *Dracophyllum* scrub is also very susceptible to fire, and it, too, must have been considerably reduced in extent.

At the upper limits of vegetation, where plants are only just able to survive, fire had serious results. Over large areas, the vegetation was replaced entirely by bare scree, and open fellfield communities expanded to much lower levels. It is probable that much of the fire damage was done in the first few decades of settlement, but the effects at higher altitudes are still becoming increasingly obvious. At lower altitudes, fire, in conjunction with grazing, has markedly altered the species composition and physiognomy of the grasslands.

Several areas of forest have been burned relatively recently. The largest area, shown in Figures 1 and 2, was burned between 1918 and 1920, with few apparent ill-effects, and the forest has been replaced by short-tussock grassland of quite good quality.

Effects of Grazing

The introduction of grazing animals into an area where the vegetation has developed in their complete absence has resulted in considerable modifications in that vegetation. Sheep have grazed the Castle Hill Basin continuously since it was first settled, and in the early days merinos grazed right to the upper limits of vegetation. Recently, however, many of the high basins in the Craigieburn Range have been little grazed, mainly because of their use by ski clubs, and because of a lack of musterers.

Although little accurate information is available on the relative palatability of the various species, the large fleshy herb, *Angelica montana*, has perhaps suffered more than any other from grazing by sheep. It appears formerly to have been abundant, especially on the better land,[5] but is now extremely rare and confined to inaccessible localities. Although not in general highly palatable, most of the native grasses appear to have been eaten readily in the absence of exotics. Blue grass (*Agropyron scabrum*) in particular, appears to have had, in fact, a tussock-like form. At present the native grasses are to a large degree confined to the interior of tussocks where they are inaccessible, with *Agropyron*

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[5] L. Cockayne: 'Vegetation of New Zealand' in *Die Vegetation der Erde*, Leipzig, 1921, Vol. 14, Pt. 2, p. 216.

scabrum still the most common species. Several of the scrub species have also been grazed. Dwarf broom (*Carmichaelia*) especially has been reduced in number and size, although *Hymenanthera dentata* and even matagouri (*Discaria toumatou*) have been occasionally browsed lightly. Young speargrass plants have been eaten, and, at higher altitudes, *Celmisia lyallii*.

With the reduction in number of these species, the entry of mat plants was facilitated. In addition, several other small unpalatable herbs increased, and possibly sheep contributed to the spread of certain plants by transporting and trampling seeds. Also, the opening-up of tussocks and the removal of accumulated decaying vegetation tended towards the drying-out of the soil, especially in swampy areas.

Cattle and Deer

A certain number of cattle have been run in the Castle Hill Basin, at least since 1865, and at present a number of wild cattle graze on the rolling country at the foot of the Torlesse Range. They appear to have had considerable effect in consolidating the ground and making tracks, and have probably contributed to the relative absence of bracken in this area. Possibly the tendency of cattle to pull tussocks by the roots has been a factor in reducing their number.

The destructive effects of cattle on the forests are readily apparent. The cattle penetrated throughout the smaller patches of forest and, in most cases, almost completely destroyed all seedling beech and other undergrowth. This destruction was made more serious by the fact that the most important function of watershed protection is largely nullified if the lower tiers of shrubs and herbs are removed.

In comparison, deer have not been abundant in the Castle Hill Basin. They were liberated at the Poulter River in the Waimakariri Valley in 1908 and 1909, and in the Rakaia in 1897. However, according to Ford,[6] the former herd had barely reached the basin by 1924, and even at the present time Wodziki's classification of 'lightly infested' (that is, one to two deer seen at a time) in 1947 remains correct. Although deer affect the 'dry' beech forests most seriously, their effects on the forests of the Castle Hill Basin were slight compared with the damage done in surrounding areas. They appear to have opened up the forest slightly or checked regeneration in one or two places.

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[6] In K. A. Wodziki: 'Introduced Mammals of New Zealand', *D.S.I.R. Bull. No. 98*, 1950, p. 183.

Probably their greater effect has been in the lowering of the upper limits of vegetation—a result of feeding on subalpine scrub, snow tussocks and speargrass.

Chamois are rare, although a few are present, especially on the Red Hills. However, because they rarely descend below 4,000 feet, they probably made a relatively large contribution to the destruction of the subalpine vegetation. The influence of rabbits and hares has been insignificant in the area, possibly because of the harshness of the environment. Pigs have destroyed small amounts of speargrass and other grassland species along the bush edge in the southwest of the basin. Opossums have recently become fairly abundant in the forests, but have not yet had much effect on the vegetation.

Accelerated Erosion

There can be no doubt that the vegetation cover has been decreasing since first settlement. A series of twelve line-transect recordings made by the North Canterbury Catchment Board provides evidence that in the seven years between 1947 and 1953 the cover has been decreasing, on the steeper slopes at any rate. The transects show an overall increase in bare ground of more than eight percent during this period, the transects above 3,500 feet in altitude showing an average loss of more than fourteen percent. However, it is doubtful if any decrease in the cover has taken place in many of the flatter areas, especially where sweet vernal and browntop are present.

With the decrease in the amount of cover, the agents of erosion have had increasing areas of bare ground to act on. Accelerated erosion has been more severe at higher altitudes because frosts, wind and snow are more frequent and more severe, slopes are in general steeper, snow tussock and subalpine communities are more easily destroyed and the destruction of one plant leaves a larger area of bare ground, and the soils are thin, with a loose powdery structure.

Wind erosion has been serious on many of the steep, exposed, sunny slopes, and along the edges of terraces and more exposed flats which have not a cover of exotic grasses. The effects of frost in pulverising the soil, initiating solifluction, and piling of soil upslope of each tussock are everywhere evident. Gullying is locally serious, especially on the higher slopes of Mount Constitution.

In general, accelerated erosion is a serious problem in the Castle Hill Basin, especially on the higher slopes in the Red Hills and the

Broken Hill Range. Nevertheless, the early photographs show but slight evidence of decreases in the cover, and if the large-scale decreases in the cover at higher altitudes described by Zotov and Cumberland[7] have been caused indirectly by man, then most of the denudation took place in the twenty-five years before 1882.

Entry of Exotic Species

Exotic species can become established only where the natural communities have been disturbed, and even then only where the exotic plants are able to resist both the physical environment and the more aggressive native species. In the Castle Hill Basin this combination has created a formidable obstacle, in spite of the opening-up of the cover by burning and grazing. There are less than forty exotic species of any physiognomic importance in the basin, and of these more than twenty are trees, shrubs and sown plants purposely introduced, none of which is widespread or aggressive. Of the remainder, half are weed species mainly restricted to small patches of bared ground.

Although very few species have become established in the native grasslands, sweet vernal and browntop have been highly successful in doing so in the lower areas. Wind probably has been the chief agent of dispersal, although seeds are likely to have entered with animals and amongst the seeds of other sown grasses. The early photographs suggest that sweet vernal and browntop had not reached the area by 1882. At that stage the individual tussocks stood out more prominently because the intertussock species had been eaten but had not been replaced by exotic grasses. Figure 5, which shows the present distribution of the exotic plants, is largely a measure of the distribution of these two species. Although neither is highly palatable, and although browntop tends to form a mat in this low-fertility area, their value was recognised by Cockayne[8] as early as 1919:

> It is doubtless the presence of the introduced plants which has saved the grasslands from further deterioration. Some of these plants would not be thought desirable by the farmer of the lowlands, but anything which sheep will eat can fill a want in the mountain pastures.

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[7] 'Broken River . . . Grassland limit lowered from nearly 6,000 to 4,000 feet', V. D. Zotov: 'Survey of the Tussock Grasslands of the South Island, New Zealand', *D.S.I.R. Bull. No. 73*, 1939, p. 242A; and, 'On Mt. Enys, Canterbury, it [shingle creep] has engulfed 2,000 altitudinal feet of tussock grassland, and brought its upper limit down from 5,000 to 3,000 feet', K. B. Cumberland: *Soil Erosion in New Zealand: A Geographic Reconnaissance*, Wellington, 1946, p. 71.

[8] L. Cockayne: 'Economic Investigation of the Montane Tussock Grassland', *N.Z. Journ. Agric.*, Vol. 18, No. 1, 1919, p. 4.

The third important plant is catsear (*Hypochaeris radicata*) which is prominent in the more open pastures and extends to higher altitudes. The grasses *Bromus mollis*, *Aria caryophylla*, and especially Yorkshire fog (*Holcus lanatus*) are common, as is the small herb *Linum catharticum*.

Figure 5 also illustrates the statement by Allan[9] that communities above the forest line, even where long subjected to burning, remain remarkably free from aliens. Occasional plants of catsear or sorrel are the only exotics present at high altitudes. Thus it can be said that, with the exception of sweet vernal and browntop at lower levels, exotic species have experienced difficulties in establishing themselves in the relatively inhospitable environment of the Castle Hill Basin.

Pre-European Vegetation

The study of how the vegetation has been modified illustrates several trends which, in general, apply to many parts of the Canterbury High Country as well as to the Castle Hill Basin. In this way a useful basis is provided for the reconstruction of the pre-European vegetation. The former distribution of forest is indicated by burned beech logs; and some idea of the former upper limits of vegetation can be gained from the presence of isolated remnants and from soil particles in the scree.

Forest and Scrub

There has been relatively little change in the distribution or physiognomy of the beech forest since pre-European times apart from the relatively small area of less than two square miles which has been burned. The rapid regeneration of beech and scrub in the north suggests that the forest could have been formerly more extensive in that area, but no stumps have been found.

Internally, the physiognomy of the larger areas of forest at the head of the Broken River was probably not greatly different. Although the forest floor probably had a denser carpet of moss and stunted juvenile beeches, and shrubs were probably slightly more numerous, the close canopy of beeches would probably have prevented the development of dense undergrowth, as it does now. Along the forest edges, and in smaller patches of forest, the divaricating shrubs, and, at higher altitudes, mountain totara (*Podocarpus hallii*) and *Phyllocladus alpinus*, assisted the juvenile beech to form a very dense undergrowth.

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[9] H. H. Allan: 'Indigene versus Alien in the New Zealand Plant World', *Ecology*, Vol. 17, No. 2, April 1936, p. 191.

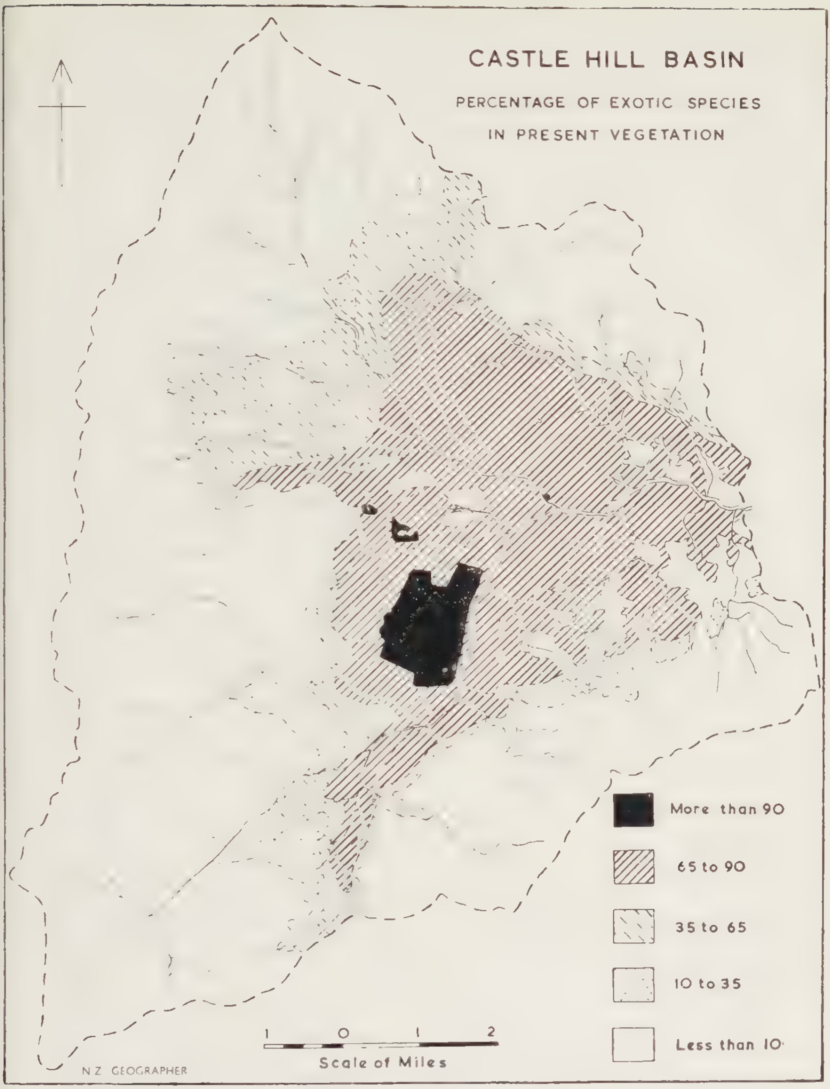

Fig. 5. Exotic species in the present-day vegetation of the Castle Hill Basin

Changes in the scrub communities appear to have been more marked, partly because they are very often not climax communities. In some cases the community has been completely destroyed, while in others, entirely new communities have become established. Matagouri appears to have been formerly more widespread. Although it is still common in dry stony areas, it was probably more thickly dotted over the grasslands, especially on the lower parts. It is repeatedly mentioned by early writers. Butler, for example, mentions matagouri thicker than a man's arm.[10] The earliest photographs give no indication that it was especially abundant on the grasslands, and possibly many of the flats were too high and exposed for the plant to become widespread. Subalpine scrub was possibly more extensive than at present and extended to higher altitudes which are now often bare.

There can be no doubt that most of the manuka and taihinu communities are induced. The early photographs clearly indicate that taihinu has entered the area round Enys, and manuka round Parapet Rock, since 1882. Even the large areas of manuka on the lower slopes of the Torlesse Range are not visible in these photographs. As late as 1899, Cockayne[11] failed to recognise any communities in which manuka or taihinu were prominent in the basin of the Waimakariri. However the slopes of Mount Constitution were frequently and severely burned up to 1950, and this, in an area of poor soils and moist climate, provided conditions favourable for the establishment of both taihinu and manuka. It is probable then, that neither of these species was common in the pre-European vegetation.

Changes have been greatest at higher altitudes (*Fig.* 6). The alpine herb and fell fields have been replaced by extensive scree slopes at their upper levels. At lower levels these communities appear to have replaced the tall-tussock grassland to a smaller extent. It is almost certain that the extensive colonies of *Celmisia spectabilis* at lower levels were formerly less widespread. Also, many of the lower fellfields appear to be induced. Apart from this, little can be said with certainty regarding the species composition. *Celmisia lyallii* may have been more plentiful, with more shrubs on the drier faces, and there was probably a denser cover of shrubs and herbs throughout.

TALL-TUSSOCK GRASSLAND

The grasslands, in general, show some important changes, both in distribution and in species composition, although the general physiognomy was probably not greatly different in pre-European times. Red-tussock (*Danthonia rubra*) grassland communities have probably been little changed in any way, probably because of their preference for damper localities. Snow-tussock communities appear to have been considerably more widespread, for at lower altitudes large areas have now been occupied by short tussock. The early photographs show no signs

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[10] Butler: *op. cit.*, pp. 10, 53-54, 60.

[11] L. Cockayne: 'Plant Geography of the Waimakariri', *Trans. N.Z. Inst.*, Vol. 32, 1900, pp. 95-136.

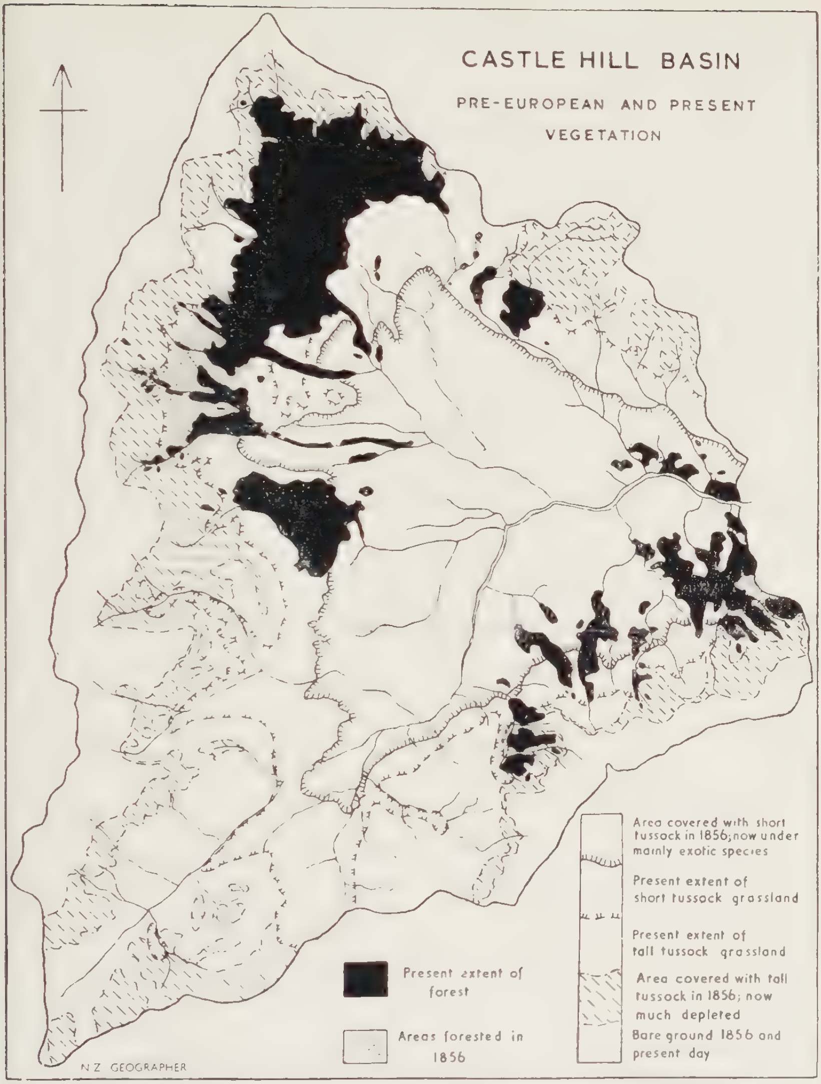
CASTLE HILL BASIN
PRE-EUROPEAN AND PRESENT VEGETATION
Present extent of forest
Areas forested in 1856
Area covered with short tussock in 1856; now under mainly exotic species
Present extent of short tussock grassland
Present extent of tall tussock grassland
Area covered with tall tussock in 1856; now much depleted
Bare ground 1856 and present day
N Z GEOGRAPHER

Fig. 6. Changes in the vegetation of the Castle Hill Basin

of snow tussock on the exposed flats at lower altitudes, and it is doubtful if snow tussock ever descended to these areas. Nevertheless the statement that the Kaikoura soils normally supported snow tussock[12] is almost certainly correct for most of the surrounding hill country. As late as 1899 Cockayne[13] observed that the upper limits of the short-tussock grassland were as low as 1,925 feet. It may have been considerably below this level in pre-European times, although it now averages almost 3,300 feet.

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[12] R. S. Gibbs and J. D. Raeside: 'Soil Erosion in the High Country of the South Island, New Zealand', *D.S.I.R. Bull. No. 92*, 1945, p. 21.

[13] Cockayne: 'Plant Geography of the Waimakariri', *op. cit.*, p. 127.

Figure 7 illustrates the general trend of changes in the altitudinal zoning of the various plant communities. The present contrasts between sunny and shady faces were probably much less marked, with snow tussock descending almost as low on sunny as on shady faces. Probably the growth was slightly more luxuriant in the latter areas, and included a larger proportion of the more mesophytic herbs—*Angelica montana* for example. The increase in short tussock on sunny faces is probably due to the greater effects of fire and to more concentrated grazing in winter.

The upper limits, on the other hand, were higher, and have been lowered by the encroachment of scree and, to some extent, of more open alpine communities. It is probable that the upper limit of the snow tussock in the Castle Hill Basin was slightly above 5,000 feet, and above this level it was replaced by discontinuous herbfields and scree slopes. This pattern is still approached in the relatively little disturbed areas above the bushline in the northern Craigieburns; but elsewhere the upper limits are very often as much as 500 feet lower.

The physiognomy was formerly somewhat different, owing to the denser cover of tussocks and the larger proportion of speargrass and *Celmisias* (especially *C. lyallii*) and, probably, *Angelica montana*. Species of the herbfield and tall-tussock grassland were closely intermingled at higher altitudes, and even the transition to short-tussock grassland was probably much more gradual.

Short-Tussock Grassland

The short-tussock grassland communities have suffered the greatest changes in species composition, for in them burning and grazing were most widespread, and they are characterised by a climate more suitable for the spread of exotic species. The importance of this latter factor is illustrated by the percentage of ground covered by exotic species in quadrats recorded by the North Canterbury Catchment Board—for example, sixty percent of the area is covered by exotic species in the area round Parapet Rock. It has already been mentioned that the short-tussock grassland formerly occupied a much smaller area, and thus has increased at the expense of the tall tussock.

Probably the most significant difference in the physiognomy of the pre-European short-tussock grassland was the relative abundance of

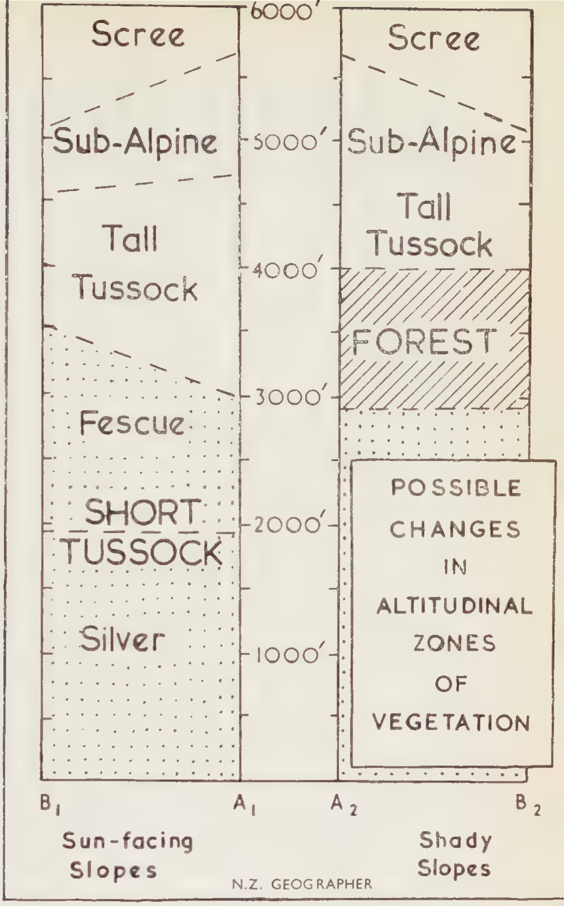

Fig. 7. Diagram to illustrate possible changes in altitudinal zones of vegetation in the Castle Hill Basin. A_1 and A_2 represent the pre-European state, B_1 and B_2 the present state.

speargrass. Cockayne[14] considered that it was still the most characteristic feature of the grasslands of the Waimakariri in 1899. It is noticeable in the photograph taken in 1868, but is not visible in any of those taken in 1882, and it is now uncommon. However, indications of its former prominence are provided by a fenced plot of the North Canterbury Catchment Board in Starvation Gully—about a mile southeast of the Castle Hill Basin. In four years of freedom from grazing by stock the plot of one square chain was found to have almost 700 young plants of speargrass—more than double the number in the surrounding grasslands. Apart from matagouri, several species of the small, green, leafless shrub *Carmichaelia* were probably common,[15] although little evidence of them now remains.

The grasslands proper were dominated much more completely by larger, closer-growing fescue tussocks. This was still the case in 1882, as is clearly shown by the early photographs. Although the cover was probably less dense in the drier, central area, in most parts the fescue tussocks almost touched each other. Blue tussock was much less common, and its place was largely taken by tussocks of *Agropyron scabrum*. Amongst the tangled and decaying vegetation of the intertussock spaces, the grasses *Deyeuxia*, *Dichelachne* and *Koeleria* were prominent, and the broad, green leaves of *Angelica montana* were probably common in the more favourable localities. Most of the small herbs such as *Wahlenbergia gracilis*, *Brachycome sinclairii*, *Celmisia laricifolia* and *Anisotome* were present, although almost certainly in smaller quantities that at present. The small sedges *Luzula campestris* and *Uncinia* were, on the other hand, probably more plentiful. Mat shrubs and herbs and twitch grasses were probably very uncommon, and large areas of bare ground were rare.

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[14] Cockayne: *loc. cit.*

[15] L. Cockayne and C. E. Foweraker: 'Plant Associations around Cass', *Trans. N.Z. Inst.*, Vol. 48, 1915, p. 174.

CONCLUSION

It must be admitted that the evidence for both the distribution and composition of the pre-European vegetation is scanty, and many of the conclusions reached must be to some extent subjective. However the results are sufficiently reliable for the making of certain generalisations. These include, first, the fact that the general physiognomy of the pre-European communities was not greatly different from that of the present day. Nevertheless, tussocks in the short-tussock grasslands were formerly much more closely spaced, and other native grasses and herbs filled the intertussock spaces. Second, the snow tussock formerly extended to much lower elevations—almost to the rolling country in the interior of the basin. At the same time, the upper limits of vegetation extended much higher—into what is now shingle scree.

The main causes of these changes have been burning and overstocking, particularly in the earliest decades of settlement. They have brought about a more xerophytic environment, and although probably all the original species are present, their relative proportions are much changed. Mat plants have become more prominent at higher altitudes, and exotic grasses at lower levels. The higher areas have also suffered severely from accelerated erosion, with the rate of depletion accelerated by the relatively dry climate of the Castle Hill Basin. It appears that much of this accelerated erosion was initiated in the earlier years of settlement, and since 1882 at least, it has been active but unspectacular.

A POLITICO-GEOGRAPHICAL APPRECIATION OF NEW ZEALAND FOREIGN POLICY

J. K. CUNNINGHAM

IT WAS NOT without a geographer's awareness of location that Lord Macaulay, more than a hundred years ago, described how a future New Zealander would stand on London Bridge and survey the ruins of St. Paul's. But the remote location, which in Lord Macaulay's time seemed to ensure that New Zealand would survive anything short of a second flood, has disappeared today. Certainly Nevil Shute in his new novel, *On the Beach*, gave New Zealand and Australia several more months of life than the remainder of the world. He had remembered his physical geography only too well. The remorseless shift of the trade winds carried a lethal load of radioactive dust even to the Antipodes. For anyone who read the book it did not present the morbid imaginings of a novelist but a disaster that could easily happen. Yet, as the last general election with its almost complete absence of debate about oversea issues indicated, the bulk of New Zealanders are still preoccupied with domestic affairs.

AWARENESS IN THE NORTH

Between elections, successive New Zealand governments, advised by a small, but efficient, Department of External Affairs, have endeavoured to orient the attention of New Zealanders towards their country's newly-acquired Pacific responsibilities. In 1946, the annual report of the Department of External Affairs devoted as much as thirty-five percent of its regional coverage to Asia, and between 1948 and 1956 approximately forty percent. In 1957 the coverage was twenty percent.[1] Yet the nation as a whole has followed, if at all, most reluctantly. Perhaps interest has been greatest in Auckland, for the people of the north are clearly more Pacific-conscious than those in the remainder of New Zealand. A simple reflection of location, this difference was well borne out in the latter half of the nineteenth century when Sir

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The annual reports of the Department of External Affairs appear in the *Appendices to the Journals of the House of Representatives* under the reference A.1. These figures, of course, are partly a reflection upon the relative importance of the year's international events within Asia. For example, the low figure for 1957 is largely explained by the preoccupation with the Suez crisis.

Julius Vogel dreamed of creating a South Seas Trading Company with its headquarters at Auckland.[2] About seventy years later, Auckland was the only major city to experience what could be termed a large-scale American invasion during the second World War, when it served as an assembly and sailing point for operations in the Solomon Islands.[3] Not since the time when the northern part of New Zealand served as a cosmopolitan whaling headquarters in the early years of the nineteenth century had Auckland been so important to the remainder of the Pacific.[4] When in November 1957 the editorial columns of the New Zealand press were preoccupied with the general election, only the Auckland paper, the *New Zealand Herald*, carried a leader on the election which took place in Western Samoa.[5] In fact, both newspapers in Auckland have long waged a campaign to rouse New Zealand to an awareness of Pacific and Asian problems. Their campaign has undoubtedly contributed to the greater public controversy over international relations to be found in Auckland. While a former editor of the *New Zealand Herald* was the principal spokesman at New York for the dominion's official stand over the Suez crisis, the present editor of the *Auckland Star* questioned this stand in a series of courageous editorials.[6] It happened nowhere else.

LETHARGY IN THE SOUTH

Rather surprisingly, the population of Wellington does not seem to exhibit any special interest in foreign affairs, despite the presence in its midst of Parliament, Government House, the Department of External Affairs and fifteen foreign embassies. Popular interest in oversea events appears little more vocal than that on the other side of Cook Strait in Nelson, which was only saved from being the country's capital by the judicial decision of a commission of New South Wales magistrates in 1864.[7] Perhaps the newly-created Department of Asian Studies at the Victoria University of Wellington, and the holding of the next SEATO Council in the capital city, will help to effect a change. In the south, the public orientation, if any, seems to be in the opposite direction. For some years now, the citizens of Christchurch have been accustomed to accepting Harewood and Lyttelton as the air and sea staging points for large-scale exploratory and scientific work in Antarctica, just as at an earlier date Port Chalmers and Dunedin were linked with the pioneer shipborne expeditions of Shackleton, Scott and Byrd. It is probably correct to say that southern New Zealand in general exhibits a greater awareness of the white deserts making up the polar ice cap. This enhanced popular appreciation of the strategic uncertainties and mineral possibilities of Antarctica[8] goes some way towards balancing the greater awareness of the Pacific exhibited in the north of New Zealand.

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[2] *Append. Journ. House of Repres.*, (A-6), 1871.

[3] A. Gillespie: *The Pacific: Official History of New Zealand in the Second World War, 1939–1945*, Wellington, 1952, *passim*.

[4] See K. B. Cumberland: 'A Land Despoiled: New Zealand about 1838', *N.Z. Geographer*, Vol. 6, No. 1, April 1950, pp. 13–34.

[5] *N.Z. Herald*, 14 November 1957.

[6] *Auckland Star*, October and November 1956.

[7] *Append. Journ. House of Repres.*, (D-2), 1864.

Significance of Southeast Asia

But even for New Zealand as a whole, the epic journey of Sir Edmund Hillary all but eclipsed the dispatch of fresh New Zealand troops to fight Communist terrorists in the jungle of Malaya. New Zealand is undoubtedly much more conscious of her 'Near North' than she has ever been, but several factors operate to keep national interest at a level lower than it should be. One that tends to be overlooked is the deficient news service from that area. The press tends to provide priority for European and American news because of the larger supply from those continents. The lack of New Zealand press and broadcasting representation in Southeast Asia is perhaps even more pressing than the shortage of New Zealand diplomats there. How many New Zealanders realise that Indonesia constitutes a region as large as the Arabian peninsula, and that regional quarrels there are perhaps as inevitable as differences between members of the Arab League? How many New Zealanders appreciate that the Singapore their troops may well have to help to defend, guards, in the form of the Malacca Strait, a maritime passage as important as the Suez Canal? How many New Zealanders realise that Russia is contriving to leapfrog over SEATO into Indonesia in the same way as she leapfrogged over the Baghdad Pact by gaining influence in Egypt? How many New Zealanders know that the regular alternation of their High Commissioner for Southeast Asia between Singapore and Bangkok involves a distance almost as great as that between Auckland and Sydney?[9]

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[8] It is doubtful, however, whether it includes appreciation of such geopolitical situations as that of an Antarctic coastland over which New Zealand claims sovereignty blocking access to an interior over which the United States claims sovereignty.

[9] The headquarters of the New Zealand diplomatic mission to Southeast Asia is situated at Singapore, but periodic visits to Bangkok are necessitated by the presence there of the SEATO secretariat.

The essence of New Zealand foreign policy, viewed regionally, is to be found in the necessity to cultivate a threefold relationship with the United Kingdom, the United States and with non-Communist Asia. All three have to be pursued concurrently and in such a way as to avoid conflict between them. A measure of irritation and misunderstanding from time to time should be recognised as unavoidable. The nightmare that should haunt the leaders of New Zealand is that they might on some occasion be forced to make invidious choices between the three partners in order to further New Zealand's interests.[10]

American and British Views of Asia

To be able to appreciate New Zealand's midway position, some attention must be paid to Anglo-American differences over Asia. One way of helping to understand these differences is to contrast the geographical approach of the two nations to the Far East. In essence, it is represented by the contrast in routes followed by Vasco da Gama and Columbus. Britain, along with other West European imperial powers like Portugal, France and Holland, has always approached her Asian empire from the east. Spain alone among the maritime powers of Europe regarded her Asian possessions as a western extension of her empire. This Spanish tradition was taken over by America. With the settlement of Oregon and California, the United States became the heir to Spain in the Pacific and the successor to the tradition of the galleons. Not long after her internal frontier had disappeared, the United States bought Alaska, annexed Hawaii and conquered the Philippines. In the light of these facts it is not too difficult to understand why, for long enough, the Republican Party, in particular, tended to be isolationist when it looked across the Atlantic Ocean back towards Europe, and tended to be imperialist when it looked across the Pacific at Asia.[11] Such an outlook perhaps received its most extreme expression with General MacArthur, who, to all intents and purposes, claimed that America's interests in Europe were at best an expensive form of philanthropy, and that the nation's true destiny was to advance alone in the Pacific and Eastern Asia.

In contrast to the American viewpoint, the Far East as seen from

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[10] The essence of Australian foreign policy can be stated in the same terms. See Greenwood: 'Australia's Triangular Foreign Policy', *Foreign Affairs*, Vol. 35, No. 4, July 1957, pp. 689–704.

[11] W. Lippmann: *Public Opinion and Foreign Policy in the United States*, London, 1952, p. 21. For an excellent geopolitical account of Anglo-American differences in Asia, by no means outdated, see G. F. Hudson: 'Will Britain and America split in Asia?', *Foreign Affairs*, Vol. 31, No. 4, July 1953, pp. 536–547.

London is, above all, 'Far'. It is further away than is to be measured by mere distance in miles, for there are many countries intervening, and a space occupied by crowded lands is psychologically much greater than an expanse of empty sea such as lies between Seattle and Tokyo. Along with other West European countries, Britain is anxious lest any conflict in some other part of the world should seriously divert military strength away from the European front. The Russians across the Elbe are much nearer to Britain than are the Chinese Communists poised on the Mekong. One of the basic principles of British foreign policy is to avoid, even at the cost of great sacrifices of interest and prestige, any involvement in a Far Eastern conflict which would require diversion of British power from areas of greater importance.[12]

Australian Attitudes

New Zealand is as sensitive as Britain to the danger of being involved in a continental war on the Asian landmass. But whereas Britain, along with the other West European nations, is fearful of American support being withdrawn from Europe, insular New Zealand is more acutely conscious of small resources—human and material—being drained away in a fight suitable only for continental giants. The wheel has turned full cycle. Back in the late nineteen-thirties, it was New Zealand, along with Australia, that was worried lest the outbreak of war in Europe diverted the bulk of the Royal Navy from the Pacific and left her at the mercy of an unfettered Japan. However, the feeling was much stronger in Australia than it was in New Zealand. Australia in the late nineteen-thirties was already thinking along lines not reached by New Zealand until well after the second World War. In 1939, Europe was for Australia by no means of exclusive, or even predominant, importance.[13] The Australian Government was prey to constant anxiety lest Britain's overriding preoccupation with Europe led her to overlook the probable consequences of her European policies in Asia. The difference between the New Zealand and Australian attitudes was well revealed by the Australian concern at possible British-Soviet cooperation against Nazi Germany. As Russia was the one European power other than Britain which was also a great power in Asia, it was Australia's fear that any

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[12] Yet such an assumption has its weak points: 'At present America shows an ostentatious lack of interest in keeping Hong Kong out of the hands of the Communists and Britain exhibits the same attitude towards Formosa. Yet both must know that they would in fact both be involved in the fate of either.' (G. Crowther: 'Reconstruction of an Alliance', *Foreign Affairs*, Vol. 35, No. 2, January 1957, pp. 182–183).

[13] N. Mansergh: *Survey of British Commonwealth Affairs: Problems of External Policy, 1931–1939*, London, 1952, p. 154.

rapprochement between Britain and Russia might compel Japan to align herself with the Axis, and thus make peace in Asia directly dependent upon peace in Europe. Throughout the late nineteen-thirties, therefore, the Australian Government generally favoured a policy of conciliation in Europe. On the other hand, New Zealand was continually urging a more positive stand.[14] This anti-appeasement of New Zealand has normally been attributed to her Labour Government's elevation of international relations to the plane of morality, but the foregoing explanation would suggest that New Zealand's relative lack of consciousness concerning her location in the Pacific must also be held partly responsible.

This fundamental difference in the geopolitical thinking of New Zealand and Australia was one of the factors which led the latter after Pearl Harbour to withdraw her troops from the Middle East, and the former to retain them there. Today the relationship between possible European and Pacific theatres of war is even more trigger-sensitive that it was, but this time New Zealand is much more aware of the fact. In the second World War there was ultimately a Pacific as well as a European war, but they were geographically separate spheres of conflict. Germany had no territorial base in the Far East; and Japan, although engaged in hostilities in China, remained neutral in relation to the European war for more than two years after its outbreak. Today, however, the situation is different. The Soviet Union straddles Europe and Asia, so that any crisis which involved the United States in an armed conflict in Europe would also mean a Russo-American war on the other side of the world. This is an important factor in explaining why New Zealand, after consultation with Britain, transferred her formal military responsibilities from the Middle East to Southeast Asia.[15]

NEW ZEALAND POLICIES

The vital question is how New Zealand, with her triangular foreign policy, adjusts herself to the basic geographic contrast inherent in the British and American approach to Asia. Some kind of compromise has of course been essential, and although the outlines are at times blurred, the compromise has tended more often than not to take the form of a regional division in which New Zealand foreign policy follows the British lead in the Far East proper, or what may be called the 'Far North' from the New Zealand point of view, and the American lead in Southeast Asia, or the 'Near North'.

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[14] New Zealand was a firm advocate of an international military force under the League of Nations. See *Append. Journ. House of Repres.*, (A-5a), 1936.

[15] See *Append. Journ. House of Repres.*, (A-1), 1955, pp. 22-23.

In the 'Far North', New Zealand is keen to see direct American action restrained and made more responsible by the necessity of having to work through the United Nations. The most important recent example was New Zealand's initiative in bringing the tense situation over the Formosan Strait before the Security Council in 1955.[16] It was largely a reflection of her anxiety lest acute American sensitivity over the area precipitate an unwanted war with Communist China. Superficially, there would appear to be evidence that New Zealand, apart from such rare incidents as above, does follow the American lead in the 'Far North', but on closer examination the evidence is not so conclusive. For example, although New Zealand made a valuable contribution to the Western cause in the Korean war,[17] unlike the Formosan issue it was a case of helping to resist overt Communist

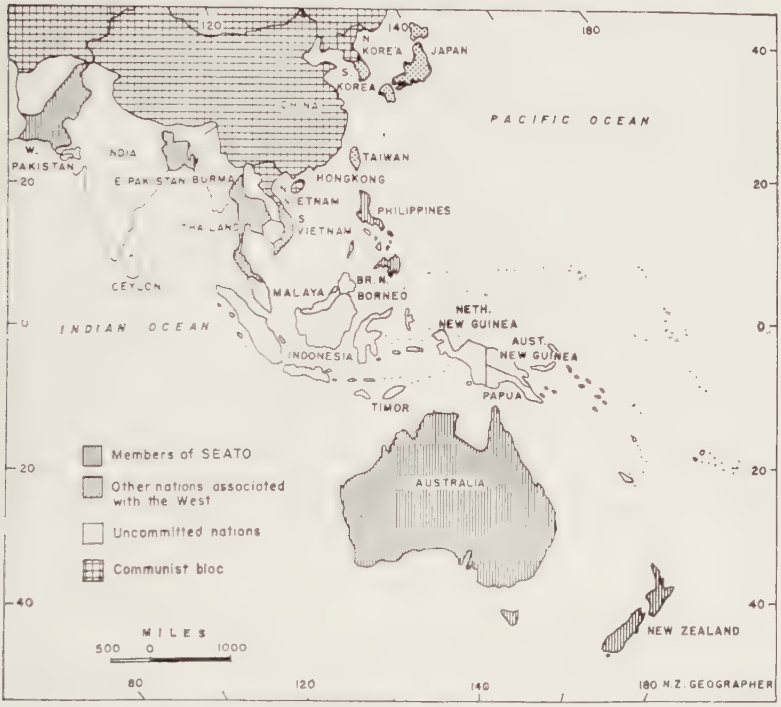

Fig. 1. Political alignments in the 'Near' and 'Far' North. Dependencies have not been differentiated.

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[16] *ibid.*, pp. 15–17.

[17] *ibid.*, (A-2), 1951 and 1952, *passim*.

aggression or of being a partner to appeasement. Moreover, by the happy accident of Russia being absent from the Security Council, the 'police action' was fought under United Nations rather than American auspices. Again, in not recognising Communist China, New Zealand would appear to have followed the American rather than the British lead in the 'Far North', but it is common knowledge that both political parties and the electorate in New Zealand favour the British policy of diplomatic recognition, and successive governments have only refrained from following the United Kingdom's example through a tactful deference to public feeling within the United States.[18] Whether a new Labour Government will do likewise remains to be seen, but an exploration of the market possibilities of Communist China[19] could indicate an ultimate determination to follow the British lead all the way. New Zealand first joined the ANZUS Pact largely through the desire to obtain American protection against the possibility of a re-emergent Japan in the 'Far North'.[20] However, since then, New Zealand has become converted to America's view that Communist China has replaced Japan as the main threat in the Pacific, and as a consequence, her main attention has been shifted from the 'Far North' to the 'Near North'.

British Weakness in the East

It has long been customary to date the decline of effective British military strength in the region of New Zealand's 'Near North' from the sinking of H.M.S. *Repulse* and *Prince of Wales* in 1942, and although their loss was largely the outcome of unfortunate specific circumstances at the time, such as the partly-accidental absence of air cover, this dramatic naval reverse did symbolise Britain's weakness in the area. However, preoccupation with it has too often blinded observers to subsequent signs, not all of them directly related to the Southeast Asian theatre. The most recent, the Suez crisis, was a much more telling indication that in an emergency Britain would experience difficulty in quickly mobilising limited resources, and would have little strength to deal with a crisis in Southeast Asia should it erupt simultaneously with trouble elsewhere. Many conclusions have been drawn from the Suez crisis, but an important one for New Zealand, seldom if ever made, is a reaffirmation of how British foreign policy and strength has been ultimately based on a scale of regional priorities which set Europe and the Mediterranean first, the Middle East and Indian Ocean second, and Southeast Asia and the Far East by a long way third. That is why, of necessity, New Zealand must follow the American lead in her 'Near North'.

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[18] J. K. Cunningham: 'New Zealand as a Small Power in the United Nations', *Political Science*, Vol. 9, No. 2, September 1957, p. 43.

[19] *Dominion*, (Wellington), 17 March 1958, p. 11.

[20] An excellent analysis of New Zealand's fears concerning Japan appears in W. F. Monk: 'New Zealand faces North', *Pacific Affairs*, Vol. 26, No. 3, September 1953, pp. 220-229.

The rare occasions when New Zealand has taken a stand opposed to America have invariably concerned issues located outside Southeast Asia. It was so during the Suez crisis, and it was so when the pro-Communist state of Guatemala was invaded from Nicaragua in 1952. New Zealand's objection to the American attitude on this latter, and lesser-known occasion, was based not upon sympathy for Guatemala, but upon insistence that the Security Council's jursidiction should not be limited by the initiation of concurrent action by a regional organisation—in this case the Pan American Organisation dominated by the United States.[21] Such a stand by New Zealand would be most unlikely if the regional organisation concerned was SEATO. Yet modern transport and modern methods of warfare have made the world a small one, and the political geographer could well argue that the independence displayed by New Zealand over Guatemala arose from the false assumption that the dominion's vital interests in the Pacific were not at stake. New Zealand's pro-Britain official stand on the Suez crisis, although mainly an emotional one determined by the weight of public opinion, was rationally justified by reference to the value to New Zealand of keeping open the Suez Canal.[22] Although this point was obvious, it is strange that there was no New Zealand reference during the Guatemalan crisis to the value of keeping open the Panama Canal, which, after all, takes a much larger percentage of New Zealand's exports and imports than the Suez Canal.[23] Admittedly the Panama Canal does not pass through Guatemala, but it is not so many miles away.

MERITS OF REGIONALISM

It may well be asked to what extent New Zealand politicians have appreciated this pattern of regionalism which has been laid over international relations in the postwar years. A small minority have not. Even at the last general election, in 1957, some candidates were still critical of Britain's exclusion from the ANZUS Pact.[24] Apparently they failed to appreciate that this exclusion is the regional counterpart in the Pacific of New Zealand's exclusion from the North Atlantic Treaty Organisation in Western Europe. In the new equalitarian commonwealth which has evolved since the war, New Zealand helps to represent Britain on one side of the world in the same way as Britain helps to represent New Zealand on the other. But quite apart from this, they failed to realise that one of the reasons for the creation of SEATO, of which Britain is an important member, was to answer the criticism of her absence from ANZUS. However, in their acceptance of regional security pacts, successive New Zealand governments of both parties have appreciated the merits of regionalism in an approach to international problems. This was most recently illustrated, at the Manila conference of March 1958, by the prime minister's mild note of warning concerning the proposal to link more closely the West European, Middle East and Southeast Asian treaty areas.[25] Using what has virtually come to be a geographer's language, he stressed the intrinsic individuality of separate security regions.

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[21] *External Affairs Review*, April 1955, p. 24.
[22] *Append. Journ. House of Repres.*, (A–1), 1957, pp. 9–12.
[23] *External Affairs Review*, August 1956, p. 20.

Implications of Land and Sea Power

The policy of Communist containment, to which New Zealand is so closely committed through SEATO, follows in general outline the 'heartland' thesis first formulated by the English geographer, Sir Halford Mackinder, over fifty years ago.[26] America and her allies are desperately striving to restrain a Communism, largely based on land power, by binding tightly around its perimeter a cordon, largely composed of sea and air power. A chain of offshore islands and archipelagos stretching from the Aleutians to the Philippines have been turned into a fleet of aircraft carriers line abreast. Along with Australia, New Zealand has been assigned the task of providing land forces to meet any emergency in peninsular Southeast Asia. At first the idea of New Zealand providing land troops in a possible Asian war seems to border on the fantastic in view of the dominion's absurdly small population. But upon deeper consideration, it will be readily conceded that New Zealand hardly possesses the industrial resources to provide even a fraction of the necessary naval and aircraft support. Moreover,

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[24] *Otago Daily Times*, 20 November, 1957, p. 4.

[25] *Evening Post*, (Wellington) 12 March 1958, p. 13.

[26] For some pertinent comments upon the concept of the 'heartland' as related to New Zealand, see J. W. Fox: 'New Zealand and the Pacific: Some Strategic Implications', *N.Z. Geographer*, Vol. 4. No. 1, April 1948, pp. 24–48.

Malaya, where the New Zealand troops are stationed, and above all the Kra Isthmus, on the borders of Malaya and Thailand, provide a Thermopylae to 'Austral-asia'.

A mountainous isthmus enables the minimum number of men to be used with the maximum effect; but only under conditions of conventional warfare, for such a restricted area would be an ideal target for an enemy nuclear bomb. In any case, although it has been argued by some that the West's rimland position would give it an advantage in a nuclear war because Communist territory would be ringed by Allied bases, such a thesis ignores the extreme vulnerability of the ports, such as Singapore, through which the maritime Western powers are virtually compelled to operate. In contrast, the peasant-army enemy, similar to the Communist force in Korea and always capable of merging with the local populace,[27] would provide scarcely any targets in the form of key dispersal points. All these factors apart, the West's reluctance to give up nuclear weapons is to be associated with an awareness of numbers in a minority camp. In many ways, it represents a revival of the old fear inspired by the 'yellow peril', although of course, in a different context. In short, the Western powers feel that they need nuclear protection to offset their numerical disadvantage. From this extremely generalised viewpoint, Western adherence to atomic retaliation may be seen as a reserve weapon in support of the maintenance of racial segregation. Fortunately, although New Zealand may have been, or still is, an unconscious accomplice to this pernicious idea, she has never been on record for supporting anything but a genuine desire for bilateral nuclear disarmament.[28]

Geopolitics of Nuclear Weapons

Although any advocacy of unilateral nuclear disarmament is the last expedient to be sought, it is questionable whether the majority of New Zealanders are conscious enough of Asian feeling against nuclear weapons and of the geopolitical explanation that largely lies behind it. Have enough of our countrymen asked themselves why the test explosion of a Russian H-bomb brings few protests from free Asian countries despite the fact that the fall-out must have been so many hundreds of miles nearer home than the bombs exploded by Britain and America in the virtually empty Pacific? Although it may be unpleasant to contemplate it, New Zealanders should remember that Asians will never forget that the only two atomic bombs ever dropped on human targets were directed by the West against them. The awkward fact that Germany, unlike Japan, had surrendered before the bomb was completed, is conveniently forgotten. This goes a long way towards explaining the Afro-Asian bloc's extreme sensitivity to the continuation of atomic tests by the West. It helps explain why Japan, almost twice as far away from the United Kingdom's testing grounds as New Zealand, protests violently, whereas neither New Zealand's government nor her people even demur.[29] Yet as long as Communists refuse to couple abolition of tests with a foolproof inspection scheme, the West can scarcely give up producing bigger and better bombs even if they want to.[30] What they must do is to see that the nuclear race is kept restricted enough to maintain conventional forces as well, because if they disappeared or were too seriously neglected, then a war could hardly be fought except by nuclear means. Such a war would be disastrous for New Zealand land forces in Southeast Asia, and, in the long run, disastrous for New Zealand, for it would be the precipitating factor in a colour war to which there could be only one ultimate result—the complete overrunning of the West, with perhaps European Russia included, by the rest of the world.

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[27] See W. Baldwin: 'China as a Military Power', *Foreign Affairs*, Vol. 30, No. 1, October 1951, pp. 51–62.

[28] *External Affairs Review*, October 1957, pp. 23–27.

DEFENCE AGAINST THE NORTH

As island outposts on the edge of a sea of colour, New Zealand and Australia would be among the first to be overrun. That is one of several reasons why New Zealand must be prepared to play her part in a possible *conventional* war in Southeast Asia. New Zealand patently can have no desire for Southeast Asia to continue in its historic role of a 'bridgeland' receiving invasion after invasion from north, east and west.[31] In the past, the great deserts in the north and interior of Australia have repelled rather than attracted settlement and have discouraged invasion and migration from the north. However, an evermounting population pressure, the new enticement of nuclear-age minerals, and the evolution of new techniques for colonising arid areas are perhaps all serving to alter the picture. The last thing Australia and New Zealand want is the re-emergence of the land bridge which possibly enabled the great southern continent to be peopled in prehistoric times. Nothing short of a geological or climatic revolution could restore the land bridge, of course, but Indonesia has been endeavouring to secure its equivalent by claiming sovereignty over the continental shelf which underlies the shallow seas between the republic's hundreds of islands. Needless to say, New Zealand has joined Australia in vigorously resisting these spurious claims.[32] An associated, though little publicised, problem for Australia has been the dilemma of whether to advance the opening up of Australian-administered New Guinea or whether to leave it comparatively underdeveloped, in which state, as the Pacific war proved, it constitutes a more effective defensive rampart to Queensland and the Northern Territory.[33] New Zealand is fortunately spared a similar dilemma, for her trust territories in the Pacific are small islands—albeit islands which the Japanese in the last war tried to occupy with the aim of fencing off Australia from the United States.[34] Communism must never be allowed to extend a military advance so far, and New Zealand shares that responsibility. At the present, New Zealand troops are receiving their most important training in the jungle of Southeast Asia itself, but in order better to meet any future emergency, it would be invaluable if the main military camps within New Zealand could be transferred from open tussocklands to hill areas with an abundance of thick rainforest. Australian troops are sensibly trained within the forest country of tropical Queensland.

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[29] The only official protest has been one directed against the United Kingdom Government for failure to inform New Zealand of the precise timing of a test.

[30] Bertrand Russell's thesis that even a temporary period of world domination by Communism would be preferable to the risk of nuclear devastation may, in its ruthless logic, be correct, but the chances of its acceptance are non-existent.

[31] This is perhaps the dominant historical theme revealed in D. G. E. Hall: *A History of Southeast Asia*, London, 1956.

A Politico-Geographical Appreciation

Political geography is a point of view as much as a field of study, and unless other viewpoints are kept in mind, it can impose a dangerous oversimplification upon the complicated field of international relations. However, as applied to New Zealand foreign policy in the Pacific, it does permit of several generalisations which, if appreciated as such and not treated as infallible rules, can increase appreciation of the dominion's role in the contemporary 'cold war'.

First, regional patterns within the country are to be detected in New Zealand's consciousness of her external political policies, but they are of little importance and modify only in detail the general indifference to oversea events. However, there is no region of 'Middle West' isolationism. Because of their dependence upon oversea markets, New Zealand farmers, even if they are not particularly conscious of foreign policy, do not possess that rooted aversion to look outwards that characterises so many of their kind in other lands. Second, for small countries like New Zealand which are consumers rather than producers of security, a genuine independence in foreign policy is virtually impossible. Generally speaking, New Zealand can only afford to adopt an independent attitude over a contentious issue when that issue is so located in the world that it does not directly impinge on what New Zealand deems to be its vital interests. This generalisation would appear particularly relevant in distinguishing between the policy New Zealand pursues in her 'Far North' as compared with her 'Near North' in the Pacific. In the former, New Zealand is less inclined to follow the lead of the United States than she is in the latter. Third, the small size and lack of financial and industrial resources which compel New Zealand to supply forces for conventional warfare rather than massive nuclear retaliation are very much in her own interest, for the use by the West of nuclear weapons against Asians would, regardless of the immediate outcome, transfer the 'yellow peril' from being a bogey to being an inescapable fate. Finally, New Zealanders should never forget that, viewed from Asia, the two Pacific dominions appear as a southern extension of that giant teeming landmass. There is no intervening ocean such as that separating the easternmost Pacific islands from the shores of the Americas. As a consequence, events and developments occurring in the multiform and multiracial 'land bridge' of Southeast Asia should be pondered over by New Zealanders as anxiously as they analyse events at home.

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[32] *External Affairs Review*, January 1958, p. 21.

[33] McAuley: 'Defence and Development in Australian New Guinea', *Pacific Affairs*, Vol. 23, No. 4, December 1950, pp. 374–375.

[34] See G. W. Warnecke: 'Suetsugu's Fence—Key to Pacific Strategy', *Pacific Affairs*, Vol. 15, No. 4, December 1942, pp. 430–449.

VILLAGE SETTLEMENT IN TONGA

T. F. KENNEDY

DURING the last thirteen years Tonga has changed little.[1] Those changes which have occurred have been largely the result of an increased national income from soaring copra prices, and take the form of improved amenities such as electric lighting and telephones in Nuku'alofa; roads, schools and hospitals; and the increasing use by Tongans of radios, bicycles, sewing machines, motor trucks, drapery, bread and tinned meat. The greatest change, however, has been in the population, which, partly because of improved medical services and infant welfare, has increased by forty-five percent to 56,000. Some slight changes, too, have occurred in the distribution of settlement. Some islands, notably Nuiafo'ou, or Tin Can Island, then occupied, have been evacuated following a volcanic eruption; and new villages have been created on other islands.

In the field of agriculture the greatest improvement has been in copra production. Prior to 1942, Tongan copra had the reputation of being of the worst quality in the Pacific. As Simkin pointed out,[2] this was to be attributed to the haphazard methods of collecting and drying, the meagre encouragement from private buyers, and the low prices ruling during the 'thirties. Since 1942 the Tonga Copra Board has, by advice, strict grading and inspection, both encouraged and compelled growers to improve their product. Locally-built hot-air dryers are now widespread and Tongan copra is today ranked among the best in the Pacific.

Tonga is unique, at least in the Pacific, in being a self-governing kingdom under British protection, ruled wisely and well by Her Majesty Queen Salote Tupou and her ministers. Europeans there are almost entirely employed by the government in advisory, professional or technical capacities, but as Tongans educated overseas become qualified to fill key positions, the services of Europeans are correspondingly dispensed with, and although the total substitution will be a long process, it will inevitably occur.

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[1] See C. G. F. Simkin: 'Modern Tonga', *N.Z. Geographer,* Vol. 1, No. 2, October, 1945, pp. 99-118.

[2] Simkin: *op. cit.*, p. 109.

Polynesians, ranging southwards from Samoa, first settled in Tonga in about 500 A.D. They found a widely-scattered group of high volcanic and low raised-coral islands. They established themselves, not only on the main islands, but also on many of the smaller islands, which, although now uninhabited, show evidence of past settlement, probably on a family-unit basis. Wave erosion has exposed profiles showing ancient graves and middens on islands as little as nine acres in size.

Unlike most other groups, in Tonga the high volcanic islands are not more advantageous to settlement than the low coral islands. This is because of their relatively small size and consequent lack of permanent freshwater streams, steep slopes, occasional volcanic activity and poor landing-places, for the shorelines are rocky and there is an absence of barrier reefs. It is the coral islands, then, which have been the centres of occupation because, even though they lack streams, they offer easier facilities for gardening, fishing and communication.

House and Garden Before 1800

Some doubt exists as to the form of settlement prior to 1800. Tasman, who visited the group in 1643, commented that there were no villages: 'every man lived in his own garden, the allotments being separated by reed fences'. Cook, a hundred and thirty years later, having seen considerably more of the islands of the Pacific than Tasman, reported a similar pattern of settlement. The presence today of ancient small gravemounds in widely-scattered areas tends to substantiate these reports.

However, these apparently dispersed dwellings may have virtually been in groups covering a proportion of the land held by each chief. Both Tasman and Cook observed houses surrounded by *well-cultivated*

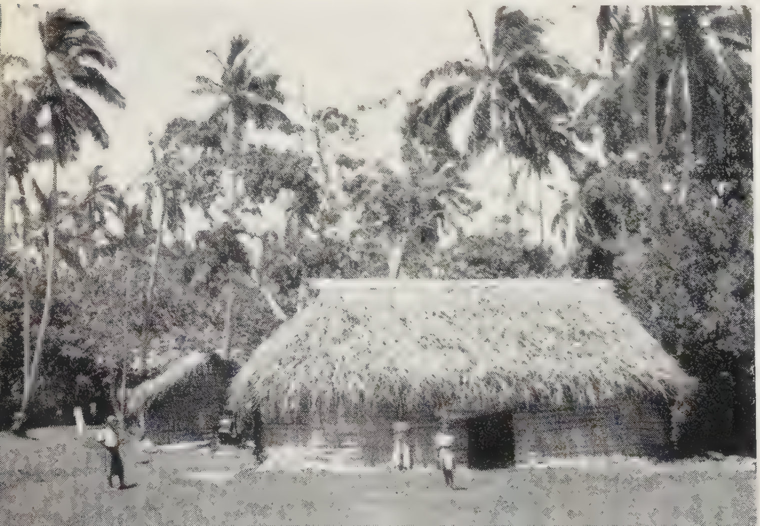
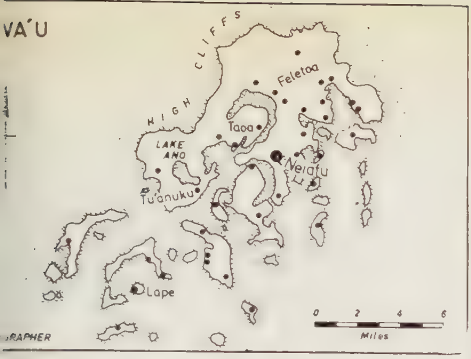
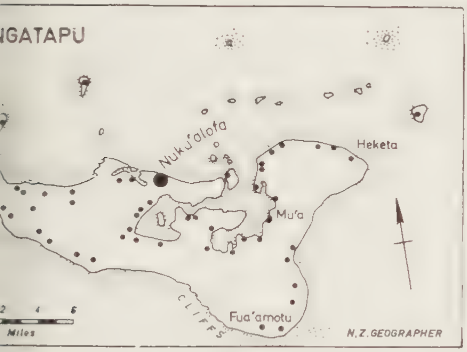
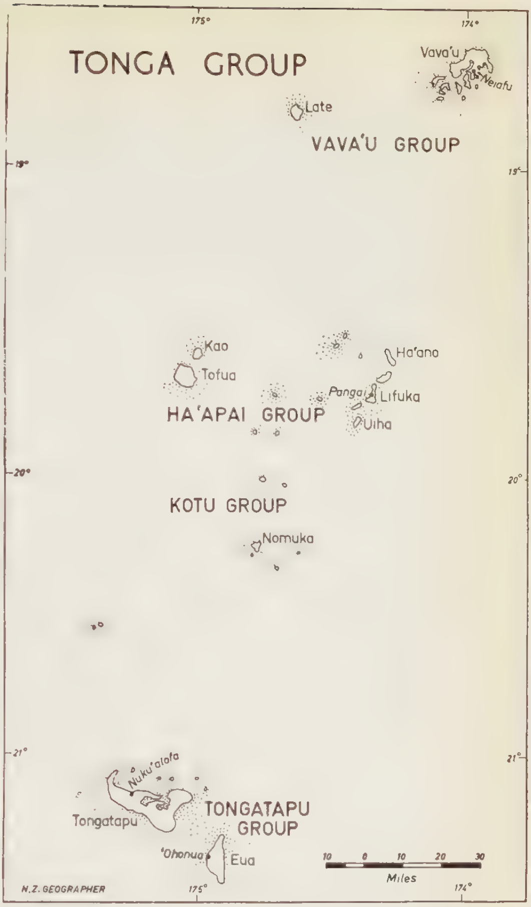


Fig. 1.
The traditional Tongan *fale* with plaited walls and thatched roof. The kitchen is at the rear.



gs. 2, 3 and 4. The chief islands of the Tonga Group





gardens and separated by fences. An area of three or four acres would have been adequate for each family and as much as one man could reasonably have kept 'well cultivated'. On this basis a group of fifty families would have occupied an area of about two hundred acres. This being a comparatively small area, the settlement pattern would in effect represent a village, though quite different in form from its modern counterpart in Tonga.

Cook's estimate of the population in Ha'apai and Tongatapu was rather less than one third of the present numbers, and it is reasonable to assume that proportionately less farmland than at the present day would have been needed, for methods of cultivation today are not substantially different from those of that time.

Fort Settlement

In the eighteenth century it was the custom for many chiefs to visit Fiji, where, in return for assisting Fijian chiefs in warfare, they received large canoes, spears, and bows and arrows of a kind not made in Tonga. Contact with tribal fighting and its taste of conquering

Fig. 5. Houses of varied construction

Fig. 6. A large family group

power was a contributory factor to the civil wars which broke out in Tonga at the end of that century as a result of bitter rivalry between two chiefs, Tuku'aho and Finau. These wars marked the end of the 'house and garden' period of settlement. The people, under their own chiefs, built large earth-walled forts and lived in them for safety. Little planting was done as the danger from ambush was great and food crops, when they reached maturity, were plundered by raiders. Such planting as was carried out was, of necessity, a communal effort, and the great forts of Neiafu and Feletoa in Vava'u had between them a large common yam field.

It is estimated that during the first quarter of the nineteenth century a quarter of the population died as victims of war or famine, and settlement was perforce characterised by villages within forts, a pattern which persisted until the acceptance of Christianity, at least nominally, by the Tongans. Vava'u and Ha'apai were Christianised before Tongatapu and it was not until 1852, under Taufau'ahau (King George Tupou I), that forts as such ceased to exist throughout the whole group.

Beginnings of Modern Settlement

A half-century of living in relatively closely confined village forts was apparently not conducive to a reversion to the old 'house and garden' pattern. The villages remained on the fort sites, but spread outside the encompassing walls and ditches when Tupou I decreed that each man's house should occupy two-fifths of an acre. The allocation of farmland was set at eight and a quarter acres (one hundred fathoms by one hundred fathoms) for each male over sixteen years, and although this meant travelling some distance from the house to grow food, the advantages of village life were sufficiently great to cause the village pattern to be retained. With increasing facilities such as wells and water tanks, small stores, churches and schools, and the opportunity for communal work and gossip in such activities as tapa-cloth making, the village has now become a very strongly-knit unit—and this in spite of the fact that, with the years, land allocation, which may place a farm several miles from the village, has increased the inconvenience of such a settlement pattern.

Villages other than those on old fort sites have been established in convenient situations on the estates of nobles or on crown land, and there are at present one hundred and twenty-one villages and three towns in the kingdom.

Village Sites

Most Tongan villages are situated near the sea. Not more than three or four are more than half a mile from coast or lagoon. This pattern of settlement is to be expected in a land where water for bathing is scarce and where sea foods are an important source of protein in the diet. Yet not all villages are actually on the seashore. Some are on hills, some perhaps half a mile inland. In this way the advantage of nearness to the reef and to the sea has been combined with considerations of protection, shelter, communication or health.

Feletoa and Taoa in Vava'u are examples of villages built on small hills for protection. Feletoa, as a fort, has the added advantage of a freshwater spring nearby. Tu'anuku is a ridge-top village which has recently been shifted there for health reasons. The original site, by a small lake at the foot of the ridge, was damp and unhealthy. The village plan is thus unusual in Tonga, extending as it does in a long line along the ridge with house sites one deep on each side of the main street.

Many villages on the low islands have been built right on the seashore on the sheltered side of the island, particularly in Tongatapu. The question of shelter is important, especially from hurricanes in the northern islands and from strong and persistent southeast trade winds throughout the group. Villages on the south and eastern sides of islands

7. A house of Tongan shape but of corrugated iron. Communal water tank on the right

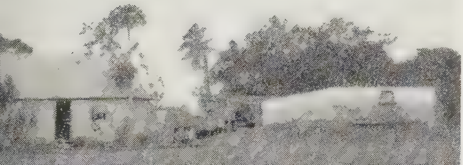


Fig. 8. Lean-to house with verandah, small concrete water tank, and small iron bathing shelter (left)

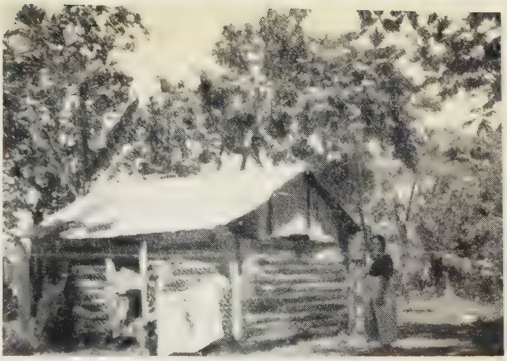
are far enough inland to be sheltered by the bush. The importance of access to the sea is well demonstrated in the islands of Vava'u and 'Eua, both of which have one side which is bounded by high cliffs. There are no villages on the 'high sides' of these islands. The chief villages of Ha'apai (Pangai), 'Eua (Ohonua), and Nuiatoputapu (Hihifo) are at the only breaks in the fringing reef suitable for navigation by small vessels. On many of the small islands, landings are possible only by canoes at high tide in calm weather, and so shelter becomes a primary site factor.

The two largest islands, Tongatapu and Vava'u, are extremely fortunate in possessing good harbours, and here are to be found the chief towns, Nuku'alofa and Neiafu. Nuku'alofa, the capital, a composite of four villages with a population of 9,200, is easily the largest settlement in the group. The thirteenth-century capital was at Heketa at the eastern end of the island, a site with little in its favour. The daughter of the king disliked the sound of waves on the reef and had her house built some miles away at Labaha on the shores of the quiet central lagoon. On the death of the king, her brother, who became Tu'i Tonga, shifted his capital to Labaha (Mu'a), where it remained until 1845. This site had sheltered water and passage for small craft to the open sea. In 1845 Nuku'alofa was chosen as capital, and, in view of later overseas shipping communication, is obviously the better location with its deep harbour protected by a barrier reef seven or eight miles offshore. Neiafu, in Vava'u, has an even better site than Nuku'alofa. Situated on gently sloping ground, it overlooks one of the best and most beautiful harbours in the Pacific.

Village Structure

There is little difference, apart from size, in the character of Tongan villages. Each village is a scattered collection of houses of various kinds, each on its own allotment. Usually the village area is an open grassy space with scattered shade trees here and there. Practically no house sites are fenced off, although there may be a small fenced area for a garden or for keeping pigs, but this is rare. Pigs roam the village, a low gate in house doorways preventing them from entering the houses. Each village has a well and one or more large communal concrete water tanks. Churches are to be found in every village, but vary in magnificence: some are large stone and concrete structures with stained-glass windows built at a time when labour and materials were

. 9 (right). Poorly built, with plaited walls and an iron roof



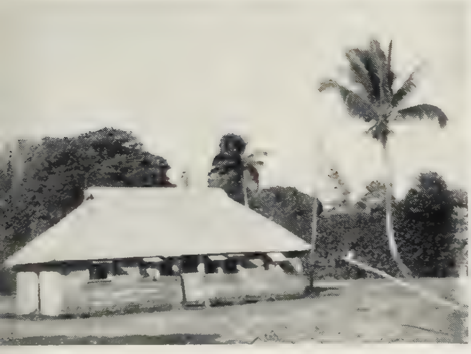
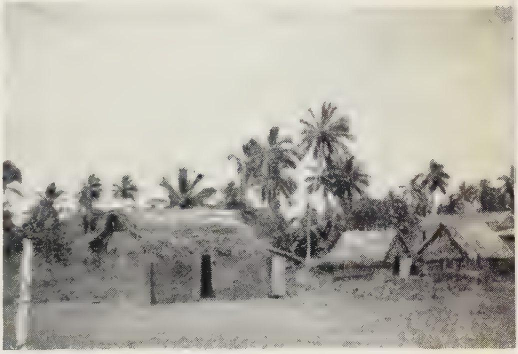


Fig. 10 (left). Better built, with grass walls and an unusual iron roof

. 11 (right). Poorly built, with biscuit-tin walls and a thatched roof



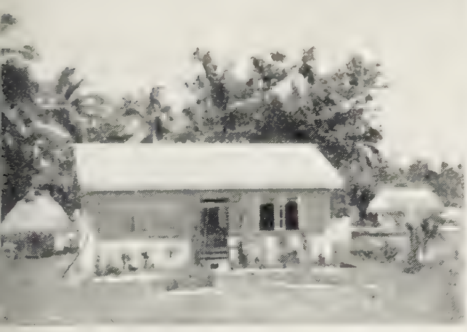
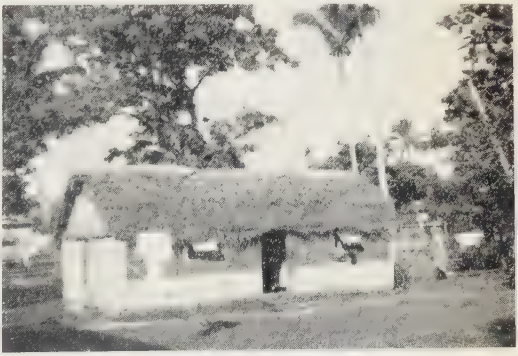


Fig. 12 (left). Well built, with concrete walls, iron roof, and glass windows

. 13 (right). Walls from boxes and crates, and a thatched roof



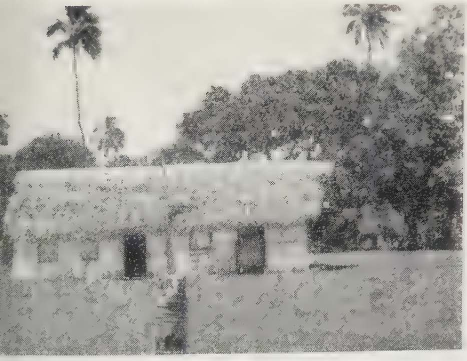


Fig. 14 (left). Walls of rarely-used bamboo, and a thatched roof

STYLISTIC VARIATIONS IN TONGAN HOUSES

very cheap, some are wooden buildings, and some are large buildings built in Tongan style. Schools are not a feature of every village as they usually provide for the children of two or more villages within a radius of two miles. A house, usually a corrugated-iron shed, is used for making tapa cloth and provides a communal workplace for village women. Finally, although the towns are the main shopping centres, everyday goods like tinned foods, sweets, tobacco and kerosene are sold in small local stores of which there may be one or more in a village, according to the size of the population. Since the introduction of payment for quality of copra, small hot-air dryers have also become a feature of many villages.

Most villages have a population of between one hundred and fifty and four hundred people. There are a few larger villages of over eight hundred, such as Fua'amotu, and three — apart from the towns — of over one thousand. Mu'a, the old capital, has a population of two thousand five hundred. A few tiny islands, such as Lape, have very small villages of less than fifty people. A village of three hundred people consists of about fifty houses, and although families range from four to fifteen people, the average size is about six.

Drift to the Towns

An urban drift, relatively well marked, exists in Tonga, and the three main centres have more occupants per house than the villages, Nuku'alofa, Neiafu and Pangai having 8, 7.6 and 8 occupants respectively as compared with an average of 6.47 for the whole of Tonga. This movement has three causes. First, many Tongans on reaching the age of sixteen do not take up their allotments of eight and a quarter acres, either because the land has not been surveyed or because they are not prepared to go to allotments on other islands. These lads come to town where they live with relatives, on whom they live, or they obtain casual work. These landless Tongans are beginning to present a social problem, and a thorough cadastral survey at present

Figs. 15 and 16. European-style: weatherboards, corrugated iron, and a verandah

being made is partly designed to overcome this. The second factor is common to most countries—the social and sporting amenities of town life. An additional magnet is the higher quality of education in town schools. Tongans are keen to see their children attend such schools, though it means living in town under poorer conditions.

House Types in Villages

A great variety of house types is to be found. The traditional Tongan *fale* of a wooden-pole frame, walls of grass, reed, or coconut-leaf, and a roof of grass or reeds, is gradually becoming less popular. Houses are increasingly being built in a European style, of timber with iron roofing, or as a Tongan-style *fale* in combinations of wood, iron and thatch. A timber and iron house is more durable than a *fale*, the roof and walls of which need renewing every two or three years; it is less damp; but, above all, it brings its owner greater prestige. However, timber is expensive and consequently, once the house has been built, the wood and iron are practically never painted nor properly maintained, and soon the houses become ugly and untidy.

Iron roofing on either timber or thatched-wall houses is very desirable as rain is the only source of safe drinking water and soft washing water. Accordingly, iron roofs provide a catchment for tanks, but not all are used for this purpose. In Vava'u, although two-thirds of the houses have iron roofs, only one-third have their own water tanks, many people being content to rely on the large communal concrete tanks provided by the government, even though acute water shortages often occur during dry spells in October and November.

Considerable differences exist between the islands in the proportions of house types within the village. Because of better shipping communications and the larger incomes available from cash crops such as copra and bananas, the three main islands have a much greater proportion of houses built of imported timber and galvanised iron. At least thirty percent of the houses on these islands are of timber, with iron roofs in European style. None of the smaller islands has a greater proportion than thirteen percent in European style, and a few have villages of completely native construction. Of the three main islands, Vava'u, chiefly on account of a greater per capita export income and the need for water-storage tanks, has easily the highest proportion of European-style houses—48.5 percent—whilst, as might be expected, the main centres have a high percentage of wooden houses: Nuku'alofa, fifty; Neiafu, sixty-two; and Pangai, fifty-eight (Table I).

The term 'European style' covers a wide range of types, including square shed-like structures, houses on the ground or on piles, elaborations of these with lean-tos, and square houses with verandahs. The traditional Tongan house—the *fale* with thatched walls and roof over a pole frame—has typically rounded ends to both roof and walls. Many Tongans, building with wood and iron, still like to preserve the traditional shape, in some cases as a link with their culture, in others because replacement of the thatch with wood and iron has been made over the old frame. Accordingly, considerable variations occur in the combination of shapes of houses and the materials of which they are constructed. (See Figures 5 to 20.)

TABLE I

BUILDING MATERIALS: TONGAN HOUSES*

	Tongatapu	Vava'u	Ha'apai	'Eua	Nuiatoputapu
Wood; Iron Roof (European Style)	30	48.5	31.7	11	13.3
Thatched Walls and Roof	44.6	29	37	68.5	66.6
Thatched Walls; Iron Roof	2.4	3.1	8.9	6.4	1.2
Wood or Iron Walls; Thatched Roof	13.6	3.4	3.4	9.3	16.7
Wood or Iron Walls; Iron Roof (Tongan Shape)	9.4	16	19	4.8	2.5

* Percentage numbers of houses on each island

The timber used for walls is chiefly imported oregon pine, although some locally-sawn timber is used on Tongatapu, Vava'u and 'Eua. Packing-case timber is quite widely used but does not command the social prestige of sawn timber. Window glass is largely a luxury and is quite rare except in the more pretentious houses.

Obviously, the great variety of materials and styles in house construction, combined with lack of maintenance and a minimum use of

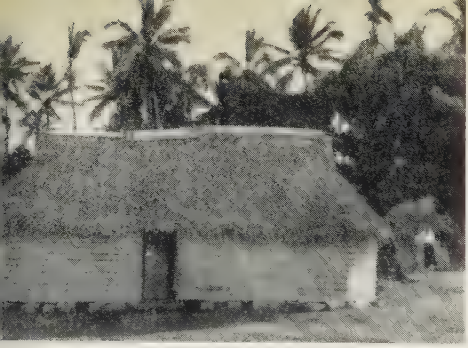
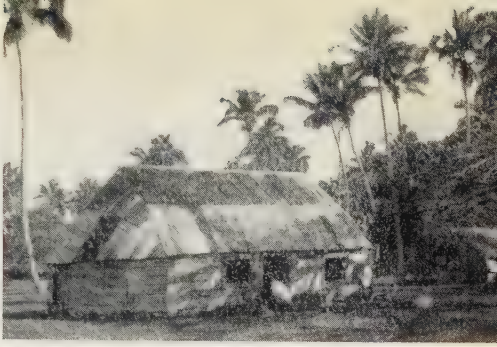
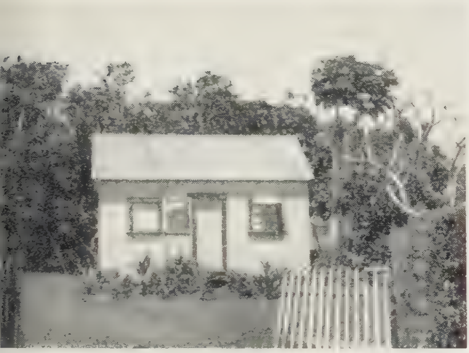
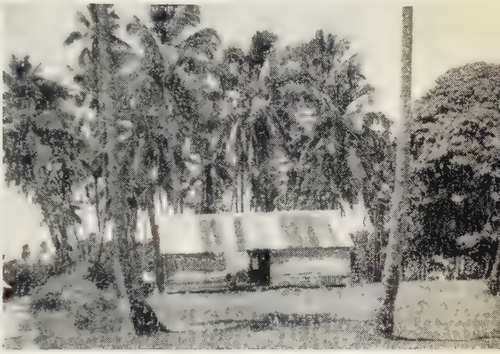





Fig. 17 (top left). Timber walls, thatched roof, Tongan shape, no windows
Fig. 18 (top right). Timber walls, corrugated-iron roof, Tongan shape
Fig. 19 (bottom left). Timber walls, corrugated-iron roof, unusual well-kept garden
Fig. 20 (bottom right). Timber walls, iron roof, square-ended, no windows

paint, results in villages of great heterogeneity, with scattered, untidy-looking houses clad with rusty iron dominating the picture. Compared with the few villages with houses of predominantly Tongan materials, the modern village presents a sorry contrast. One argument in favour of wooden houses is improvement in health standards with better ventilation and wooden floors above the ground, but if these houses are to be encouraged by the authorities, some standard of maintenance should be insisted on by village groups. A start in this direction has been made by Queen Salote who has encouraged the setting-up of home-improvement groups among village women, but, although women are on the brink of emancipation, the men are not yet inclined to be guided by them in village matters. A team of the World Health Organisation is commencing a two-year study of village hygiene in Tonga and it is to be hoped that their report to the government will result in efforts towards housing improvement.

A survey of villages shows very few houses where reeds are used for building. Coconut fronds are now widely used as they are easy to obtain and are much quicker to plait and use. However, they are less durable than properly-thatched reed or grass, and leaf-cutting reduces coconut production. Each bunch of coconuts grows out from the axil of a frond, and so every frond cut and used results in a lowering of nut yield for food or copra. As copra is the basis of Tongan economy, the increasing use of timber and iron for building can well increase the national income, but at what cost to aesthetic values and to individual and village pride!

IMPACT OF THE WEST

European culture has had a profound influence on house types. The majority of Tongans who live outside the main centres have little contact with Europeans, and apart from their religion, they have tended to absorb only material values. Houses are the ultimate expression of these values, and the dwellings of missionaries, traders and government officers have been imitated as far as building ability, ingenuity and finance would permit. The building of European-style houses of timber and iron naturally began in the port centres beside the prototypes. With the construction of good roads and motor transport, building material became easily available to people in outlying villages. At the same time the improved transport enabled villagers to sell their copra and use the proceeds for new building.

Apart from the desire to emulate European architecture and to have a more durable dwelling, education has speeded this type of building by emphasising better houses for health reasons. It is also fairly generally accepted that most Tongans have the ambition to own a European-style house before they die.

The impact of the Western world with its demand for tropical products has increased the material wealth of most Tongans, although not all avail themselves of the opportunity. The high copra prices since the war have been reflected in increased house building with imported materials, and available figures show an increase of twelve percent in European styles in Vava'u between 1953 and 1957. Finally, an increasing number of Tongans are being educated overseas. On their return they prefer to maintain the standards of housing to which they have become accustomed, and as many are potential leaders, either in government positions or as nobles, their example must accentuate the housing trend. It is probable, though distressing, that eventually the traditional Tongan *fale* may disappear.

GEOGRAPHIC NOTEBOOK

IN THIS ISSUE. Investigations into the characteristics of vegetation, and the problems attendant upon man's interference, have long figured in scientific literature of New Zealand. Many concepts, nevertheless, have remained unchanged since the days of Cockayne, and as Dr. V. J. Chapman points out, it is useful to make reassessments from time to time. This is now done with reference to the lowland forests of New Zealand by Dr. Chapman, who is Professor of Botany in the University of Auckland.

A second contribution in vegetation studies is that of Mr. D. H. Relph, who is a teacher at the Mt Roskill Grammar School, Auckland. In a previous number of the *New Zealand Geographer* Mr. Relph described the nature of the vegetation in the Castle Hill Basin today; his present study is interpretative of that nature in that he attempts to show what changes have occurred since Europeans first entered the basin.

The use of phosphatic fertilisers, trace elements and lime is so much a part of New Zealand agriculture that occasionally their significance is taken for granted, especially that of lime. Mr. L. J. King here presents an account of the geography of the agricultural-lime industry in the South Island, emphasising its regional differences. Mr. King is now studying in the United States at the University of Iowa, and his contribution is a synopsis of a thesis presented for a masterate degree at Canterbury University College.

Mr. J. K. Cunningham is also a graduate of Canterbury University College and is now Lecturer in Political Science in the Victoria University, Wellington. Political geography in New Zealand is still in the developmental stage, but, as Mr. Cunningham's contribution shows, is growing on a firm basis and demonstrates the contribution that the geographer can make to fostering a greater awareness of the dominion's political responsibilities, particularly in the Pacific.

A part of this Pacific 'neighbourhood' is the Kingdom of Tonga where Mr. T. F. Kennedy spent some years in the education services. He is now Lecturer in Geography at the Ardmore Teachers' College. As Mr. Kennedy shows, the impact of the European on the Tongan way of life is indeed real, and in no way more obviously than in the breaking-down of traditional styles of house architecture.

Other contributions in this issue have been made by Professor G. Jobberns, Dr. L. L. Pownall and Mr. G. J. R. Linge of the University of Canterbury; Messrs. B. H. Farrell, L. Curry and R. G. Ward of the University of Auckland; Messrs. W. J. Brockie and K. I. Maslen of the University of Otago; Mr. A. J. Rose of Canberra University College; Mr. G. R. Cochrane of the University of Adelaide; Messrs. J. A. Johnston and J. L. Hewland of Christchurch Teachers' College; Mr. R. W. Sage of Wellington Technical College; and the editors.

GEOGRAPHERS IN THE UNIVERSITY. The last note on some of the activities of academic geographers in the universities of New Zealand was published in the *New Zealand Geographer* in April 1956. Dr. K. B. Cumberland, professor in the University of Auckland, is on leave through this year visiting Britain and North America. A special objective of Dr. Cumberland's study will be to examine the role of geographers in regional and urban planning. His American visit is sponsored by the Carnegie Corporation of New York. Just back from a year's leave is Mr. J. W. Fox who spent most of 1957 in Great Britain and continental Europe, and who is now acting as Head of Department in Dr. Cumberland's absence. Mr. R. G. Ward will take up an appointment as Research Assistant at University College, London, in October, and Mr. R. M. Frazer has already left for Canberra where he has been awarded a research scholarship in the School of Pacific Studies in the Australian National University. Mr. B. H. Farrell has been promoted to the status of Senior Lecturer in the University of Auckland.

In the Victoria University of Wellington Mr. D. W. McKenzie has been appointed Associate Professor in the Department of Geography, and Dr. R. F. Watters, a graduate of the University and of the London School of Economics, has been appointed to a lecturership. The Department of Geography at the Victoria University has just moved into fully-equipped and commodious quarters in the new science block.

From the University of Canterbury, Dr. L. L. Pownall was away on leave in North America and Europe through 1957, being assisted in his American travel by a grant from the Carnegie Corporation of New York. A special objective of his trip abroad was the study of urban geography and its teaching. During his absence Mr. G. J. R. Linge joined the staff as Assistant Lecturer. Through 1957-1958 he has occupied the post maintained for a visiting lecturer. In 1948-1949 this post was held by Dr. H. J. Critchfield, now of the Western Washington College of Education in Bellingham, Washington. Professor Critchfield expects to return to the University of Canterbury for the teaching session of 1959. The Department of Geography acted as host for the triennial conference of the New Zealand Geographical Society in August when many of its graduates took advantage of this opportunity to celebrate the twenty-first anniversary of its establishment as the first independent department of geography in the University of New Zealand.

In the University of Otago the geography staff has been enlarged by the appointment of two assistant lecturers—Mr. P. N. Pirie in 1957, and Mr. R. P. Hargreaves in 1958. Both are graduates of the University of Auckland. Mr. Hargreaves has lately returned from a two-year course of study at the University of Wisconsin while Mr. Pirie has been doing research work in Samoa. Mr. R. G. Lister visited Adelaide in August as President of Section P of the A.N.Z.A.A.S. He expects to be away on leave in 1959 when Professor D. Linton, of the University of Birmingham, will occupy the William Evans Visiting Professorship in the University of Otago.

An event of special interest and pleasure to academic geographers in New Zealand has been the brief visit of Professor H. C. Darby in the spring of 1957. Sponsored as a Nuffield Visitor by the University of Canterbury, he gave lectures in all four university centres and addressed the various branches of the New Zealand Geographical Society.

It is pleasing to hear that of the New Zealand graduates now in Australia, Mr. A. J. Rose has lately been appointed as Senior Lecturer in Geography at Canberra University College, and Messrs. A. D. Tweedie and K. W. Robinson have been promoted as senior lecturers in the New South Wales University of Technology at Newcastle.—G. JOBBERNS

THE MARAMARUA-MEREMERE POWER PROJECT. In July 1958, electric power generation began at the new 180,000 kW steam station at Meremere a mile or so south of Mercer on the banks of the Waikato River. Most of the coal to run the station, (often called the Mercer station), will come from Kopuku six miles to the east across the Maramarua swamp. Taken together, the building of the power station and the preparation of a large area for opencast mining make this one of the largest development projects in New Zealand today.

From 1880 until 1913 coal was mined underground at Kopuku Landing, loaded on barges and transported down the Maramarua River to the Waikato River. More recently, since 1947, the old workings have been mined opencast and the coal taken by road to dairy factories in the Waikato.

Several years ago, following heavy power demands and in view of concern at the remaining water power potential, the services of an oversea expert were obtained to report on the practicability of building a thermal-electric station in the North Island. The result of the investigation was the controversial 'London Report' which recommended the construction of a station using coal from the Maramarua coalfield.

The average thickness of the sub-bituminous coal to be worked is about thirty-five feet, with a maximum of sixty feet in places. Coal lies in two steps and dips gently to the northwest. The seam, however, is irregular, and is characterised by undulations. The coal is overlain mainly by fire-clay, and in some cases by gravel, with a ratio of overburden to coal at about nine to one. Stripping will be at a rate of three million cubic yards a year and eventually two farm houses and a hill behind the present mine will have been removed. Today, the overburden is dumped on the soft mud covering of the Maramarua swamp to form a causeway along which will run two monocable aerial ropeways capable of carrying 300 tons of coal an hour to the power station.

At Meremere is a permanent village for 150 workers and their families, and a construction camp for a hundred workers has been built at Maramarua. The facilities at Meremere are correspondingly more extensive. All are dwarfed, however, by the power station with its boiler house rearing 110 feet above the land surface. The station will have six 30,000 kW generating units, the last of which is scheduled to operate in July 1959. The cost of the new power station and ropeway will be approximately £16 million.

Meremere will consume between 600,000 and 800,000 tons of coal a year, about two-thirds of it coming from Maramarua where seventeen million tons can be mined by opencast methods. Annual production will be about 500,000 tons, of which 400,000 will go to the power station and the remainder will be sent to New Zealand Dairy Company factories. The remaining 200,000 tons or more that will be required by Meremere will arrive by rail from opencast mines in the Huntly–Rotowaro district, mainly Kimihia and Weavers Crossing. But until the ropeway is completed much of the burden of supplying coal will be borne by mines of the lower Waikato coalfield. The new power developments have not only affected Maramarua and Mercer but they have had a profound effect on coal mining generally in the Huntly area and have led to a substantial increase in coal output at a time when production in the other New Zealand coalfields is stable or declining.—BRYAN FARRELL

AIR TRANSPORT AND AERIAL WORK IN NEW ZEALAND. The steady expansion of air transport within the dominion is once again demonstrated in the eleventh annual report of the New Zealand National Airways Corporation (*Append. Journ. House of Repres.*, (H-35), Wellington, 1957). The corporation has placed itself in a stronger position than it has ever previously achieved. There was a record volume of passenger traffic, the 473,783 passengers carried representing two people in every nine of the total population of New Zealand—a ratio that appears to be surpassed only by Australia. Passenger traffic increased by eleven percent, generating seventy-eight percent of the total revenue. Air freight increased by only one and a half percent but the relative proportion of revenue increased by ten percent to twelve and a half percent of the total.

Satisfactory though these increases may seem to be, in other respects the situation appears to be one of consolidation rather than advancement. Productivity of the airline fell slightly to the 1954 level (and is still considerably below that of other national airlines, for example, British European Airways), and the total revenue load factor also fell slightly. Again, while expansion of routes took place over most airline networks throughout the world, N.A.C. consolidated its route pattern by the transfer of the light-traffic South Westland service to a private airline. In addition, since restrictions have been placed on the use of Rotorua airfield, this important tourist centre is no longer served by the corporation's aircraft. August 1957 saw a further reduction of the network when the reconstruction of Rongotai, Wellington, necessitated the withdrawal of services from the existing airport. On the other hand, the completion of a sealed runway and hangar at Invercargill has enabled this city to be integrated with the main trunk route. The operational adjustment consequent upon these changes has in turn meant a reduction in the corporation's fleet from thirty-four to twenty-eight aircraft, of which twenty-six are Douglas DC-3's and two are obsolescent D.H. Dominies. While from an operational point of view this near-concentration on a single type of aircraft may be considered highly desirable, and while it is undoubtedly because of this rationalisation of its fleet that N.A.C. has been able to handle the continual expansion of traffic, it is paradoxical that, now that this object of the corporation's policy has been all but achieved, these aircraft are fast approaching the end of their useful lives. More modern aircraft have considerable advantages to offer in direct operating costs, but the initial costs of new aircraft certainly cannot be met out of the depreciation and sale of the existing fleet. While as yet no statement has been issued on the choice of a replacement on the subsidiary arteries of the network, a governmental decision of 1955 approving the extension of the fleet by the purchase of three fast, higher-capacity aircraft for the main trunk route was implemented by the delivery of the first Viscount turboprop which began operational service between Christchurch and Auckland on

3 February 1958. A phenomenon recognised by every oversea airline operating the Viscount, that this aircraft has apparently the ability to generate traffic on its own account by virtue of its unparalleled passenger appeal, is probably also occurring in New Zealand. It is surely symptomatic that in the first five months of operation the passengers carried on this sector of the network increased by forty percent. As a corollary, the introduction of this modern complicated machine has also required the provision of extensive specialised maintenance facilities at Harewood, Christchurch.

The only other domestic scheduled service of importance is the Straits Air Freight Express. Primarily specialising as a freight carrier between the North and South Islands, this company transported 24,270 tons along its two main routes through Paraparaumu, Wellington, to Nelson and Blenheim, together with a further 4,000 tons on non-scheduled services throughout New Zealand. One of the outstanding characteristics of this company's success has been the high utilisation achieved by its active fleet of three Bristol Freighter aircraft when used in conjunction with its own self-devised and developed system of pallets.

In the realm of aerial work, there has been increasing use of aircraft in almost every aspect of agricultural and allied work ('Report on the Air Department', *Append. Journ. House of Repres.*, (H-37A), Wellington 1957). In the main branch of the activity, aerial topdressing, the tonnage of fertiliser applied (428,245) represented but a five percent increase over the previous year, and contrasted markedly with the average of forty-five percent increase recorded over the previous four years. Worse than average flying conditions during the year undoubtedly accounted in part for the reduced rate of increase, as did the more stringent financial conditions. It would however appear that the developmental or pioneering phase of aerial topdressing activities has passed and that further expansion will be at a much slower rate. Provisional figures for 1958 indicating an increase of the order of nine percent appears to bear this out.

Apart from aerial bait dropping, which, after a seventy percent increase in 1956, decreased by ten percent to 4,238 tons in 1957, there was an expansion in all other forms of aerial work. In particular there was a further spectacular increase in the aerial distribution of spray materials. In 1957, 561,031 gallons of insecticide and weedicide were distributed (one third of this by helicopter)—an increase of some fifty percent over 1956, while preliminary indications for 1958 show that the extension of these activities continues with the total spray distributed reaching perhaps 700,000 gallons.

The increased amount of work was accomplished by a reduced aerial work force, indicating amongst other things a considerably increased efficiency within the aviation industry, higher utilisation of aircraft, more mechanised ground equipment, and, in all probability, the fact that the difficult period of transition from obsolete aircraft to modern specialised machines is now well advanced. Yet the current list of civil aircraft licensed for aerial work reveals that the Tiger Moth still comprises more than one half of the 315 aircraft registered.

In no other form of transport is technological advancement so important as in aviation, and it is worth noting that both the National Airways Corporation and the highly competitive aerial work operators are faced with similar problems of re-equipment. In each instance the moot point is seen to be one of high initial capital costs involving the expenditure of oversea funds at a time when the general economic situation has deteriorated. In the event of a choice having to be made, it will be interesting to see which branch of New Zealand's aviation activity the government considers must take precedence in the national interest.—W. J. BROCKIE

SOUTH AUSTRALIA: A GROWING INDUSTRIAL STATE. Dramatic industrial expansion is projected within South Australia during the next five years and heralds a new era that will alter greatly the present economy of the state. Recent proposals for industrial development and expansion are the most spectacular in the history of South Australia. Involving a capital outlay of £A60,000,000 and completion of construction plans by 1962-1963, these projects will result in a rapid and significant transition from a predominantly primary-producing state to one with a balanced agricultural-industrial economy. The all-important 'wool-wheat-wines' trilogy, long the basis of South Australian prosperity, may soon share importance with oil refining—and all its attendant integrated industries, with ferrous and non-ferrous metallurgy, and with shipbuilding and metal-fabricating industries, especially automobile manufacturing.

The Broken Hill Proprietary shipyards at Whyalla, on the Spencer Gulf, are to build a 32,250-ton super tanker costing about £6,000,000 (including a government subsidy of £3,000,000). Australian shipyards have lacked the volume of work enabling them to compete economically with oversea yards. However, the steady volume of work ensured by the present projects will do much to improve the efficiency of shipyards at Whyalla, and to bring closer the day when the industry can survive without government subsidy. One 10,000-ton ship is ready for launching, two 14,000-ton vessels are on order, the keel has been laid for one of two 19,000-ton, deep-draught ore carriers for B.H.P. Designs for a 40,000-ton ore carrier to operate between Yampi Sound and Port Kembla are under consideration. Recruitment of skilled personnel from overseas and of semiskilled workers from all over Australia will bring 500 more workers to the shipyards. In all, the new shipyard employees, and the provision of houses and of essential services, will result in an influx of 1,500 into the labour force in the next two years.

In 1960 construction will begin on a £30,000,000 steel-making and steel-rolling mills project by B.H.P. at Whyalla. This will affect many sections of industry; it should reduce production costs to builders and manufacturers; it will attract more people to Whyalla; it will provide a larger local market for the state, attract other lighter industries to Whyalla; and, because of its heavy demands for electricity, will benefit the whole state through economies from large-scale power generation at Port Augusta.

High hopes are held that use of the large reserves of low-grade siliceous iron ores west of Whyalla will ensure for Whyalla steel mills an indefinite life even when the higher-grade ores of Iron Knob and Iron Monarch are worked out. There are potentially large deposits of high-grade ore being tested thirty-five miles southwest of Iron Knob. These are in addition to the thirty million tons near Iron Knob, so the future of Whyalla seems assured.

One week after the announcement of the B.H.P. steel project, General Motors-Holden announced a £9,000,000 expansion programme for Australia, of which

£7,500,000 was to be spent in South Australia. Work began immediately on the building of a new factory and power house at Elizabeth, the new satellite town of Adelaide. There will be employment for 1,400 when the plant is operating. A further expenditure of £4,685,000 is planned at the General Motors-Holden 66-acre factory site at Woodville, Adelaide. This will involve the rebuilding and modernising of older structures.

By 1961-1962 the annual production of Holden cars will be increased from 100,000 to 125,000. Local production of automobiles plays a vital part in the Australian economy. Since 1954 it has saved the commonwealth £100,000,000 in oversea exchange; its exports have earned £2,000,000; and the government has received £26,500,000 in taxation revenue. In 1956 almost two-fifths of all registered vehicles in Australia were Holden products.

To keep pace with modern demands in production of metals for world trade, Broken Hill Associated Smelters, at Port Pirie, are improving shipping facilities, expanding storage on the flats and constructing a new £750,000 metals refinery. Planned to go into continuous production late in 1959, the eighty-foot-high refinery, with its two giant 'kettles' each weighing forty tons, will be one of the most efficient and modern of its kind in the world. All fumes and impurities are harnessed so that atmospheric pollution is avoided. This new refinery will process from 800 to 1,000 tons of zinc annually, cast the 2,000-pound lead blocks demanded by American buyers, and produce antimonal lead and cable sheathing for local industry and for export.

Fourteen miles south of the centre of Adelaide city, preliminary survey work has begun on the site of a new oil refinery. This, the Adelaide Refinery, costing £16,000,000, is designed to produce over one million gallons of petroleum products daily and is to be built on five hundred acres of land. This vast new project, similar to the Altona Refinery in Victoria, will be one of the most modern refineries in the world. Tankage capacity will be forty million gallons of crude oil and products. The refinery is excellently sited on flat ground, near the city, and close to adequate supplies of water and electricity and to deep water for anchorage for tankers. Costly port facilities are not required as a mile-long, underwater, 24-inch pipeline will allow an efficient and rapid discharge from vessels of up to 80,000 tons, safely moored in deep water.

Over 1,500 men and locally-produced building materials, including cement, bricks, steel pipes, bars, girders and other structural and reinforcing steel, will be required for the construction, giving a big stimulus to local industry. Apart from £3,300,000 for equipment from overseas, the £16,000,000 will be spent on Australian materials and labour. A twenty-four-mile pipeline will enable Port Adelaide to become an important oil-bunkering port. A new power station is to be erected adjacent to the refinery, and another on the Port River, burning oil fuel, is planned. Only the future will tell whether the price to be paid for this large modern oil refinery will be beach pollution and atmospheric pollution.

All these vast industrial enterprises, planned for completion in five years, are vivid expressions of confidence in the stability, future and industrial potential of South Australia.—G. R. COCHRANE

AGRICULTURE IN WESTERN SAMOA. To many observers, one of the most striking and disturbing features of administration in Western Samoa has been the neglect of the Department of Agriculture over a period of many years. In 1953, for example, expenditure on agriculture accounted for only 0.82 percent of the total budget—the same amount being spent in the maintenance of Government House. Education accounted for seventeen times as much, and although Samoa is completely dependent upon agriculture for her oversea earnings there was virtually no provision for agricultural education. High export prices in the postwar years tended to mask this dangerous condition. Since 1953 there has been some improvement, and in 1956 agriculture was allotted 2.1 percent of total expenditure. Along with this increase came a thorough reorganisation of the department, the appointment of a new director in mid-1956, and, at the beginning of 1957, a doubling of the seconded staff by the addition of a further agricultural officer, an entomologist and a livestock officer. Another twenty officers were recruited locally. The results of these general improvements in staffing and organisation are shown in the *Annual Report of the Department of Agriculture for the Year* for 1957. New approaches to field advisory work, proposals to set up a central agricultural college for New Zealand's Pacific territories, the extension of entomological research and livestock services, and the taking over by the department of certain aspects of the banana-marketing organisation are all new developments which bring promise of considerable advances in Samoan agriculture.

As a result of an unprecedented drought in the latter half of 1956, banana production was low for the first half of 1957 but, from 15,700 cases in June, monthly exports rose rapidly to 56,950 cases in November, so that total exports for 1957 were the second highest on record. Much of the credit for this rapid recovery must go to the work of the department's extension division in encouraging the four-thousand-odd growers and instructing them in the techniques of planting, pruning, weeding and pest control. The beginning of the education of growers in the use and value of fertilisers was another most important step. In 1957 bananas accounted for twenty-one percent of agricultural exports by value. Of the £1,700,000 received from agricultural exports, cocoa accounted for forty-three percent, with copra in second place (thirty-five percent). The estimated value of total domestic production was £550,000 (an unfortunate printing error in the value of production tables for taro has led the report to overstate this by £950,000!).

As with bananas, the increased extension and inspection work of the Department of Agriculture was also reflected in new cocoa and coconut plantings and in better management of existing plantations. Emphasis was placed on the quality of the cocoa beans and copra produced, and, following demonstrations, sixty open-hearth copra dryers were constructed in the villages. These enabled Samoan growers to make a substantial contribution to the quantity of first-grade copra produced. Previously all hot-air dried copra came from commercial estates.

Livestock farming in Western Samoa is relatively undeveloped, although with considerable areas of upland soils suited to pastures and cattle rearing, the potential is great. At present there are some 13,100 cattle in the territory, and with the appointment of a livestock officer a tuberculosis survey has been initiated and the selection of a superior herd begun on the Western Samoa Trust Estates. With measures such as these the generally low quality of livestock will be raised.

In all, therefore, the *Annual Report* gives promise of considerable progress. Whether or not this promise will be fully realised depends on the success of the department's extension work, both in initial instruction and long-term follow-up. In addition to normal work by the district officers, the concentrated resources of the technical staff were applied to intensive extension work in two villages. In the first village 'the response [was] varied and spasmodic [and] it appears that the majority of the people in Leauva'a are disinterested in anything that means work on their part.' This statement highlights some of the difficulties the department faces. However, the second operation of this type, carried out at Solosolo, was much more successful and the response of the people was very good. It seems therefore that, with a revitalised Department of Agriculture, one may look for a much healthier agriculture in the next few years.—R. GERARD WARD

OBITUARY. Members of the New Zealand Geographical Society will regret the death on 17 May 1958 of Professor Sir James Hight, K.B.E., C.M.G., M.A., LITT.D., LL.D. He was the first president of the first branch of the Society established at Canterbury University College in 1940, when he was Professor of History and Political Science and Rector of the College.

Sir James Hight was one of the most distinguished graduates of the University of New Zealand, one of its foremost scholars and teachers and, as its Pro-Chancellor and Chairman of its Academic Board over a long period, one of its most able administrators. The range of his scholarly interests was unusually wide. His M.A. degree was taken with First Class Honours in 1894 in English and Modern Languages, but he turned later to History, Economics and Political Science. His lifetime of teaching service in Canterbury University College began with his appointment as Lecturer in Political Economy and Constitutional History in 1901, but it is as Professor of History and Economics from 1909 to 1919 that the older generation of graduates will remember him best. From 1919 until he retired in 1949 he was Professor of History and Political Science, and from 1928 to 1949, Rector of the College. He was interested in education in its widest sense, and his lifelong interest in the better teaching of geography in the schools, and his encouragement of its development in the university was but one manifestation of this.

In an expression of the esteem in which he was held by all who had the privilege of personal association with him we cannot do better than quote the *University of Canterbury Gazette* of July 1958. 'Sir James Hight was one of the most distinguished of the earlier generation of the New Zealand–born. He was proud to have been a Victorian and his character exhibited many of the Victorian virtues—industry, integrity, exactness and the forward-looking habit of mind. But much that drew men to him was peculiarly his own. Though the least pretentious and assertive of men, he exerted a lasting influence over colleagues and students by his humanity and sense of justice. . . . He would never reproach if he could possibly encourage. He was slow to anger, slower still to express it; and since he looked for the best in men's characters, it was natural that they should reveal it to him. He cherished talent wherever it was to be found, and the whole stress of his work for half a century lay on making the university a place of equal opportunity.'

IN OUR CONTEMPORARIES

1. *In New Zealand Journals . . .*

Plant Geography in Coastal Otago

VEGETATION AND CLIMATE IN THE DUNEDIN DISTRICT: P. Wardle and A. F. Mark, *Transactions of the Royal Society of New Zealand*, Vol. 84, Part 1, October 1956, pp. 33-44.

This paper attempts to elucidate the relative importance of present and past climate and of human interference in determining the pattern of vegetation on the hills near Dunedin. It has again been found necessary to employ the dynamic viewpoint and the hypothesis of indigenous forest instability, so clearly propounded by J. T. Holloway in order to account for anomalies in the relationship of climate to present vegetation patterns.

The particular area chosen for study is a most challenging one to the ecologist containing, as it does, both podocarp and beech forests adjacent to high-altitude snow-tussock grassland and to lowland associations of fescue and poa tussock. This is a study on a 'microgeographic' scale permitting the authors to examine a greater number of factors than could be evaluated or measured over a larger area. Data on precipitation, evaporation and temperature were collected by the personal measurements of the authors at stations from three hundred to 2,750 feet above sea level embracing a variety of slopes and aspect. This data is shown on a climatic map which may be compared with a facing map depicting the assumed vegetation of 1850 together with the present plant associations.

There is an analysis of the limits, floristic composition and regenerative capacity of the various associations found in the district. In particular, a table recording regeneration of forest species points not only to the vigour of beech regeneration but also demonstrates the capacity of podocarps to regenerate, thus invalidating any concept of their complete senescence.

The study of climate and present vegetation in the selected area of the east Otago hills reveals anomalies which may be resolved by a hypothesis of recent climatic change and of interference by human agency in pre-European times. New successional development is explained in terms of recent reductions in browsing animals and the cessation of burning. Biogeographers will note with interest the weighting ascribed to the northwest wind as a desiccating force and the comment on the inability of snow-tussock grasslands to withstand vigorous competition from invading beech species.

The writers have shown not only the value of detailed, local studies in plant ecology but also the patent need for continued local studies in the re-evaluation of the relationship between present vegetation and climatic patterns.—J. A. Johnston

2. *In Oversea Journals . . .*

BASIC PATTERNS IN RAIL TRANSPORT

RAILWAY TRAFFIC AND AGRICULTURE IN NEW ZEALAND: W. H. Wallace, *Economic Geography*, Vol. 34, No. 2, April 1958, pp. 168-184.

To many New Zealanders their railways are something of an enigma. Devoid of the glamour of high-speed operation, sumptuously-titled trains and vivid liveries, and bedevilled by problems of road and airways competition that no one attempts to solve, the railways have lapsed into a prosaic working existence. Yet even this has every appearance of senescence. Passenger services are patronised only by those who must use them, and freight is offered only because long-distance road haulage is restricted by a system of licensing. Consequently, although the tonnage carried by rail each year shows an increase, overall receipts show a decline, and despite modernisation and the closure of uneconomic branch lines, operating costs continue to mount. Were it not a fact that railways are essential to the national economy, particularly in the South Island where most of the financial deficiencies occur, a critical situation would have forced a transport upheaval long ago.

Just how far the railways are essential is amply demonstrated by Dr. Wallace in this article. To many people, to most geographers, and to all railway geographers in New Zealand the facts set out are well known, and for that reason some would perhaps cavil at the general treatment. But as Dr. Wallace points out, precise statistics cannot be obtained, and even if they could, the picture would not be affected. Moreover, the article has not been written for New Zealand readers.

Movements of stock from farms to markets in freezing works and abattoirs; dairy produce, wool and wheat to markets in factories, ports and mills; farm to farm movements of store stock; and the flow of products from extractive and manufacturing industries to farms—all these have distinctive regional patterns with significant interrelationships. Dr. Wallace has, of necessity, had recourse to subjective interpretation, for his definitions of flows of major, intermediate and minor importance have in his maps no quantitative basis, but his conclusions are valid enough. He expresses the hope that his ideas will stimulate further work. They are certainly part of the groundwork of the definitive railway geography that has yet to be written.

As far as the present article is concerned one could object strongly to the haphazard scales on which the maps have been reproduced—but that is not the fault of the author. Full-page maps of New Zealand to illustrate features of dominion-wide extent are always the most satisfactory, and given these Dr. Wallace could have made a better attempt to represent livestock movements and to provide a full key.

—JAMES W. FOX

THE 'SECOND STRING'

INDUSTRIAL NEW ZEALAND: *Current Affairs Bulletin*, Vol. 21, No. 1, November 1957, pp. 1-16.

This slim pamphlet, a companion bulletin to *Rural New Zealand* published three years ago, attempts to show 'the other side of the picture' usually brought to mind in connection with New Zealand. It sets out to describe 'some problems and highlights' of manufacturing, mining, forestry and projects concerned with the production of energy.

Inevitably the discussion is on a very general level, and consequently some rather gross generalisations have been made. For example, although it is agreed that the size of the factories engaged in secondary manufacturing (as against processing industries) is generally small (but not 'very small') and that many (but not 'most') have under ten employees, it should perhaps have been made clear that there are about two thousand factories with more than this number of employees each, and these together engage nearly half the total workers. Furthermore, it might have been appropriate not merely to state that the characteristics of manufacturing in New Zealand are 'small plants, few workers per factory, low output per factory. .' but to explain that if the industries which New Zealand has developed are compared with *similar* industries overseas, these characteristics would apply in other countries also.

Rightly the bulletin lays stress on the development and potential use of power, but to suggest that, if extra power could be installed over and above domestic-use requirements, the surplus could be used as the basis of various heavy industries may be looking for a rather easier solution to New Zealand's difficulties than would appear to be the case.

It is, however, encouraging to read a discussion of some of the really long-term problems facing New Zealand, and a more advanced discussion of each of the broad industrial activities covered in this pamphlet might well be worthwhile. In this changing world it seems very probable that Australia and New Zealand will be drawn more closely together and a mutual understanding of such problems becomes all the more important.—G. J. R. LINGE

REVIEWS

JOURNALS OF EARLY WESTLAND AND CANTERBURY

MR. EXPLORER DOUGLAS. Edited by John Pascoe. Wellington: A. H. and A. W. Reed, 1957, pp. 331, 37s. 6d.

THE TORLESSE PAPERS, 1848-51. Edited by Peter Maling. Christchurch: The Pegasus Press, 1958, pp. 238, 45s.

The appearance of these two books is to be welcomed not only for the inherent value of their contents but also for the assurance that editors and publishers can be found to bring before a modern generation some of the forgotten diaries and papers of New Zealand frontiersmen of the nineteenth century. It is from the papers of men like Charles Douglas and Charles Torlesse that one can see the land through the eyes of its first explorers, surveyors and settlers and gain some impression of what it meant to be a pioneer.

The two books form an interesting contrast. The scene of *The Torlesse Papers* is the windswept tussock plains of Canterbury in the two years before the arrival of the 'first four ships'. *Mr. Explorer Douglas* records forty years of exploration, between 1866 and 1906, among the high mountains, dripping forests and turbulent rivers of South Westland. Almost nothing remains of the Canterbury landscape as Torlesse first knew it, whereas vast areas of the Douglas country remain substantially as he found it.

In both these books, editorial alterations to the style and spelling of the original manuscripts have been wisely kept to a minimum. Mr. Pascoe's extended biography of Douglas provides ample commentary and allows the journals to stand by themselves. Readers of *The Torlesse Papers* will be grateful for the scholarly care which Dr. Maling has exercised on his brief biography and on the numerous footnotes to the journals.

Mr. Pascoe's book falls into two parts. The first part is an illuminating and sensitive account of the life and achievements of Douglas and of the select company of pioneer surveyors, cattlemen and mountaineers who knew and loved him. Charles Douglas, the youngest son of a well-to-do Scottish family, left his job as an Edinburgh bank clerk and emigrated to Otago in 1862. In 1866 he followed the goldrushes to the ocean beaches of South Westland and remained there for the rest of his life. Gold mining had little appeal to Douglas and he spent the next twenty years 'tinkering with odd jobs' as track-cutter, cattle farmer, ferryman, survey hand, explorer and mineral prospector. In 1889, at the age of forty-nine, he began fifteen years of full-time exploring. He earned the official and unique title of 'Explorer' and came to know South Westland better than any man then or since. Then followed the loneliness and bewilderment of the lingering years of his decline until his death, almost unnoticed, in Hokitika in 1916.

The remaining two-thirds of the book contains half of the surviving Douglas manuscripts, which, thanks largely to the initiative of Mr. Pascoe, are now housed in the Turnbull Library, Wellington. These include selections of his personal letters, the diaries of his exploring expeditions, his district reports describing the physical nature and economic prospects of each major river valley, an extensive monograph on birds of South Westland, and fragments from three notebooks dealing with subjects as diverse as 'Islets, Towns and Glaciers' and 'Swamps, Bluffs and Beaches'. The book contains many excellent photographs of Douglas and the Douglas country, some reproductions of the explorer's sketches, and reference maps of the country between Ross and Big Bay.

On reading the Douglas papers one is struck with the amazing diversity of the author's talents and his extraordinary powers of observation, qualities which would be the envy of any geographer or natural scientist. As an acute observer of the land about him, Charles Douglas at his best must be placed in a class with Guthrie-Smith.

Despite his lack of formal scientific training, many of his observations and theories were in advance of those of his scientific contemporaries. Trained at the right time he might have become a first-class field geologist. Born a hundred years later he might have made a name as a forest ecologist. His writings show a deep love of wildlife and a strong current of conservation philosophy. He foreshadows the setting apart of wilderness areas in national parks when he pleads 'Let us keep a few spots in Westland uncontaminated by the ordinary tourist, the picnicker and the photographic fiend . . . keep them for those who care to risk their necks and enjoy scenery in a state of nature'. Douglas was also aware of the limited resources of the West Coast at a time when most 'coasters were thinking expansively of that glorious future when the "Something is bound to turn up" does turn up.'

Some may be inclined to dispute Mr. Pascoe's view that the Douglas 'sketches are not art', for Douglas gave a more perceptive interpretation of the New Zealand mountain landscape than many better-known artists of his day. Geographers will regret that it was not possible to reproduce at least one sample of the explorer's maps, for in cartography as in geology, art and ecology Douglas was a self-trained 'primitive'. His bold crayon maps, sprinkled with amusing anecdotes or cryptic descriptions of terrain, have a rough-hewn character befitting the frontiersman who drew them and the wild landscapes they represent. Mr. Pascoe's list of the Douglas maps (p. 308) omits the valuable timber reconnaissance map of South Westland, housed in the Department of Lands and Survey, Hokitika. Until recently this was the only complete map of forest types available for the area.

The West Coast of the South Island is a land rich in legend but it has been poorly served in literature. All praise then to Mr. Pascoe, not only for rescuing Charles Douglas and his manuscripts from legend and obscurity, but also for making an important contribution to the regional literature of New Zealand.

Charles Torlesse, a nephew of Edward Gibbon Wakefield, arrived at Port Cooper in 1848 as a member of the survey party led by Captain Thomas. After an initial reconnaissance of the central plains had left the party in no doubt that here rather than the Wairarapa was the best site for the Canterbury settlement, Torlesse spent most of the next two years on a triangulation survey of the plains. Dr. Maling, who was responsible for locating the Torlesse papers in England and in securing their loan to the Canterbury Museum, has selected for publication part of the surveyor's diaries and several of his extended and informative letters.

To the historian Dr. Maling's book will be valuable for the light it throws on the events and personalities of the period. It is a corrective to the popular misconception that Canterbury history began with the arrival of the 'first four ships' at the end of 1850. To the geographer the book offers some glimpses of early Canterbury as seen through the eyes of one of the first men to explore systematically the plains and their borderlands. One learns that the sheepmen were apparently not the first to set fire to the tussock grasslands, and from the matter-of-fact entries of the young surveyor it seems that there was a good deal of smoke in the Canterbury skies even before the pastoral age. Of the Rakaia Gorge area Torlesse writes: 'Fired the country on our route and saw the fires of yesterday burning'; and of Ohoka Bush: 'Maoris fired the country there and burnt the bush'.

The special interests of the geographer will be found in the occasional remark rather than in a flow of continuous narrative. Thus, the brief 'steered by compass 65° in the direction of Riccarton' conveys overtones of the featureless character of the open plains in those days. Torlesse's concern at the limited and maldistributed supplies of timber is revealed in numerous notes on the location of timber and firewood, and in his journey to the South Canterbury foothills in search of rumoured coal deposits. Notes on the presence of Maori dogs, native quail, the abundance of wild pigs and references to wild cattle on the plains are all revealing to the historical geographer. Torlesse's distinction between the light soils of the plains—'country undeviating, grass and ti-palm. Light loam, shingle and gravel sub-soil'—and the heavy soils—'Fine rich land, clay sub-soil, flax, grass and tutu of strong growth'—shows that the fundamental contrasts in the Canterbury Plains landscape were apparent long before man set plough to the tussock.

The value of this handsome book is enhanced by seventeen illustrations and four maps, three of them derived from original surveys by Torlesse. The front endpaper contains a reproduction of the valuable 'Sketch Map of the Country Intended for the Settlement of Canterbury' which was recently rediscovered in Wellington, while the back endpaper is of particular interest to geographers in showing the distribution of bush patches, manuka scrub and swamps in the northern part of the Canterbury Plains.—MURRAY MCCASKILL

A NEW ZEALAND HAZARD

FLOODS IN NEW ZEALAND, 1920-53. Wellington: Soil Conservation and Rivers Control Council, 1957, pp. 239, 25s.

Officers of the Soil Conservation and Rivers Control Council, building on work begun by the Meteorological Office, have compiled a list of floods occurring in New Zealand during the period between 1920 and 1953. Each flood is described briefly, while occasionally a more extensive analysis is undertaken including the atmospheric conditions producing high rainfall. The listing is arranged chronologically and by regions, eleven in the North Island and six in the South Island. Each regional chapter begins with a general description of the hydrological conditions of the area and includes a diagram of the major river systems, noting maximum and minimum recorded flows where available. Some new maps of the seasonal distribution of rainfall and of the maximum recorded daily rainfall are included.

This is a reference book, packed with facts, which requires deep mining rather than the ground prospecting possible to a reviewer. Certain regional characteristics stand out. The many rivers of Westland have steep thalwegs but shallow bars at their mouths; to the south the rivers are fed by snowmelt as well as rain, so that most floods occur in late spring and summer. These conditions can be contrasted with the Waikato region where floods occur least frequently in summer and early autumn and where Lake Taupo regulates the Waikato River flow to such an extent that it is freshes from the Waipa River adding to a high base flow in the main stream which produce the worst floods. The Manawatu River is rather similar in that intense rain in the upper reaches causes deep ponding at Woodville and the high base flow through the gorge may have the peak flow of a fresh from the Pohangina superimposed. Aggrading rivers such as the Waipaoa or those of North Auckland flood frequently, whereas the Hutt, degrading in its lower reaches because of human activities, is flooding less frequently than previously. Taranaki, with its well-defined radial streams from Egmont, suffers few ill-effects save for the washing away of the circumferential roads and bridges. This list could be continued and it is this feature which will be most welcome to geographers.

It is a pity that the map of maximum recorded daily rainfall was presented in the form found in this volume. It was 'compiled by interpolating between stations which have recorded the same maximum daily falls since establishment'—surely an incorrect description of what appears to be a normal isopleth map. There are no indications of the number of stations used nor of the varying lengths of record of stations, a factor which could surely have been allowed for since the map has little meaning otherwise. The degree of precision shown appears absurd, particularly over large areas of the South Island where not even the average annual rainfall is known.

Floods are natural events caused by landforms and weather. They usually occur on floodplains and are destructive of property. They occur at intervals, the higher the flood, the rarer its occurrence. The controlling of all floods in a river valley will almost always be too expensive. The moral is not to buy property on floodplains unless its value has been discounted by the chances of having it damaged.

Readers conversant with the controversy in the United States over the relative merits of flood control or settlement control, and curious about the official New Zealand attitude, will read with interest the short introduction to the volume by Mr. N. L. Newnham, Chairman of the Council. Statements such as the following leave little doubt about that attitude: '. . . *any* remedial measures taken to stop or reduce these losses [from floods] will be to the Dominion's financial advantage', or 'it is imperative, therefore, that plans be made to reduce its ill-effects [i.e., from excessive rainfall] at *every* danger point' (reviewer's italics).—L. CURRY

LESSONS FROM ROXBURGH

HYDROTOWN: THE SOCIAL HISTORY OF AN INDUSTRIAL BOOM SETTLEMENT. By W. J. Campbell. Dunedin: University of Otago, 1957, pp. 122, mimeographed, 7s 6d.

This book is a sociological survey of Roxburgh Hydro, the construction town for the Roxburgh hydroelectric project. The main aim of the book is to examine 'social interaction within a transient mushroom settlement', particularly in order to find out how well the several groups of national and immigrant workers settled down together in a new environment. The author has had considerable first-hand experience of Hydrotown, extending from before the arrival of the oversea contractors in July 1952 until the protracted strike in December 1955. However, in spite of his subtitle, Dr. Campbell has not written a history but a 'case study' of certain conditions at a particular time which are not claimed to be typical of earlier or later years.

Perhaps the best parts of the book are those containing the results of surveys made early in 1954 of the uneasy relationships between management and men, and between several distinct groups of workers—New Zealanders, contract workers, British immigrants and Dutch immigrants. Many factors are shown to underlie the discontent in the early stages, including a foreign management which did not take the men sufficiently into its confidence, and the importation of a labour force of contract workers who were felt to be in a privileged position. Dr. Campbell suggests that a properly-trained personnel officer would have been very helpful here. The important point about the groups of workers was that they tended to remain separate, although there was also some intergroup hostility mainly involving the contract workers. Both these matters are dealt with very well by the author, who criticises the practice of directing immigrants in large batches to a construction camp which lacked a predominant group of New Zealand nationals with a community spirit. Assimilation into the New Zealand community was thus unfortunately delayed.

Other chapters deal with family life, with life in the single men's camps, with sporting and cultural organisations, and with education and the social activities of older children. Some of this material is inevitably rather general, but much precise information is also given, for instance about the friendship preferences at the Roxburgh District High School of post-primary pupils from the Hydro and Roxburgh communities. It is also pointed out that the appointment of a trained community director would have helped to make the social life, especially of the single men, fuller and richer.

Dr. Campbell has asked the right questions, and has provided either convincing answers or the material to help answer them. The information is clearly presented, with helpful photographs and diagrams, although more comment might have been made on the statistical tables. One hopes that this valuable survey will be read by those who are concerned with the development of future big construction schemes, and its lessons applied.—K. I. Maslen

Manufacturing in Australia

THE INDUSTRIALIZATION OF AUSTRALIA. By F. G. Davidson. Melbourne: Melbourne University Press, 1957, pp. 26.

This booklet describes briefly and competently the salient features of the Australian industrial system. The introduction sketches the history of development; the following seventeen pages are given over to a description of recent changes and the present structure of industry; the last six pages deal with 'hopes, questionings and results'. The treatment is from the point of view of the economist rather than the geographer, with little emphasis placed on location. Nevertheless, the booklet is of basic importance to geographers seeking to understand the most evident of the social forces that are at present modifying the cultural details of the Australian landscape at an unprecedented rate.

The main body of the work is initiated by a discussion of three tables showing the basic facts of Australian manufacturing—the variegated rate of expansion which has raised factory output by 50 percent in the past seven years, the number of factories, (now totalling nearly 50,000), and the number of workers employed together with value of production. Then consideration is given to the structure, methods of operation, and sources of capital employed in leading firms and industrial groups. The most detailed outline is given to the operations of Broken Hill Proprietary, surely one of the world's most benevolent monopolies, where, *inter alia*, the point is well made that 'the common idea that B. H. P. controls the non-ferrous as well as the ferrous industry is a mistake.' The automotive industry is discussed particularly with reference to the implications arising from the high proportion of American capital in this profitable field. Each industry has its points of interest, and these are noted.

The wisdom of employing governmental policy to facilitate industrial expansion in Australia has always been questioned. Now, a continuation of recent trends appears assured. Apart from considerations of defence, which must always be important, the continuing decline, absolute as well as relative, in the labour needs of rural industry coupled with the recent increases in population and the certainty of an unprecedented influx of young people into the workforce in the next fifteen years, indicate that industrialisation must remain the logical focus of Australian economic expansion. These considerations form the background to the concluding section of the booklet.

—A. J. Rose.

A Regional Geography of Scandinavia

THE SCANDINAVIAN WORLD. By Andrew C. O'Dell. London: Longmans, Green and Co., 1957, pp. 549, 45s.

Professor O'Dell is already known for his books on the historical geography of the Shetland Islands and on the geography of railways. His new book on Scandinavia will bring his work before an even wider audience, for there has long been a need for a detailed survey of this part of Europe.

This book is divided into three main parts. The first is an introduction to the physical geography and history of Scandinavia; the second is a regional treatment of Finland, Sweden, Denmark, Norway, Norway's Arctic Islands, the Faroes, Iceland and Greenland; and the third part describes the separate elements in the economic geography of these states, such as agriculture, forestry, fisheries and minerals.

The physical background is presented with a minimum of words. This reviewer would have liked the author to have enlarged the chapter on the structure and relief of Scandinavia, but it must be kept in mind that his text is aimed primarily at upper secondary school and lower university levels in Britain. The treatment of early man in Scandinavia is a fascinating account that reveals the considerable competence of the author in this special field of geography.

The main elements in the geography of each state are briefly treated in a systematic fashion at the beginning of each regional chapter. Then each major region within a state is described in turn. One can sympathise with Professor O'Dell for having to compress his description of each region into one or two pages of text when quite evidently he has still much more of interest to tell his readers.

Professor O'Dell has a first-hand knowledge of almost every part of the Scandinavian world. He has made liberal use of photos that he himself has taken, and has included many valuable tables and diagrams. Altogether there are 199 figures in 530 pages of text. Unfortunately there is no map showing the boundaries of the different regions he describes. A useful bibliography of nine pages is included.

It is to be hoped that Professor O'Dell may one day publish an expanded text that will allow him to use all his accumulated knowledge about these lands which he knows so well. In the meantime the present book will find a place in every worthwhile geographical library.—L. L. Pownall

Practical Geography in the Upper School

THE PRACTICAL GEOGRAPHER. By R. S. Coogins and R. K. Hefford. Adelaide: Longmans, Green and Co., 1957, pp. 100, 23s. 6d.

The publication of geography books for the Australasian market has developed considerably of recent years. To an already varied collection there is now added *The Practical Geographer*, a textbook in which the authors have presented an introduction to the mechanical aspects of map making, based wholly on Australian examples. It may be fortuitous that a new demand has been created for this book by an alteration in the New Zealand University Entrance Scholarship syllabus in geography, which as from 1959 devotes part of one paper specifically to 'elementary cartography (the interpretation of topographic maps, and the representation on maps of phenomena of geographic significance)'.

The book opens with a brief history of mapping, and a description of the traditional methods of map construction. These sections are clearly set out and well illustrated, but the chapter on relief representation is disappointing. In a publication with some form of illustration at nearly every opening it is a surprise to find no visual comparison of the different methods of relief representation. On the other hand, the use of two full-page colour anaglyphs (one with an accompanying contour map having eight named landforms and one for further study), complete with viewing spectacles, is novel and reasonably successful.

A useful section on the principles of map projection is well illustrated and involves a minimum of mathematical knowledge, but the statement on classification of land utilisation is not up to the standard of other chapters. This needs very careful reading to separate the four suggested schemes, while the illustrations show several others. Confusion is furthered by the use of aerial photographs, themselves useful tools, but involving interpretation techniques different from ground surveys.

In a brief statement on weather and climate, an account of conditions and instrument readings occurring with the passage of a cold front is particularly useful.

The final section is headed 'The Reading and Interpretation of Topographic Maps'. This reviewer is unaware of the status of this aspect of geographical study in Australian schools, but students and instructors in New Zealand will be very disappointed here. In a surprisingly low total of five pages, less than half a page has been given to the consideration of the distribution of cultural phenomena, and this consists wholly of questions. This gross inadequacy is slightly remedied by the inclusion of seven whole-page samples of Australian topographic maps in five colours at scales of 1:63,360 and 1:50,000. Accompanying questions direct the reader's attention to the salient features of each, but a sample set of answers would have been suggestive and helpful.

Each chapter concludes with a useful set of exercises which cover a wide range of suitable activities. A list of equipment useful for practical and field work appears in an appendix, which also gives sources of various Australian maps and aerial photographs. However, the oversea reader would have welcomed a list of a small sample group of maps which he might obtain to illustrate some of the major landscape variations within the continent.

The authors have not stated for which student group this book is intended. Its best value would appear to be as a textbook for senior high school students, apart from the sections on land-use classification and topographic maps. Some of the material covered enters into first and second year university courses, yet for these students it is inadequate.

The book is clearly printed and well indexed, but for a volume which is intended for considerable handling the binding is unsatisfactory. Nevertheless, for the material included, for its numerous and clear illustrations and the range of suggested activities, this book will be welcomed by most of the senior geography teachers of this country.

—R. W. Sage

Geography as it is Examined

SCHOOL CERTIFICATE GEOGRAPHY QUESTIONS. Edited by C. M. Herbert. Hamilton: Paul's Book Arcade, 1958, pp. 35, 2s 6d.

This small booklet contains questions set in the New Zealand School Certificate examinations in geography over the past ten years, arranged under regional headings. There is also a list of references to the geography of Australia and New Zealand. The booklet should be quite useful to teachers as a ready source of essay and test questions. As a mere list, it leaves it to the teacher to discriminate between the suitable questions and the others; and the list of references, though limited, is well chosen (with the exception of reference to some dehydrated, devitalised and potted material recently published under the misnomer of geography notes). The publication of this list of questions is further warning to future examiners of the dominant part they will apparently play in deciding what and how geography shall be taught in our schools, and an indication that they may receive severe criticism if they depart too far from 'stock questions'.—J. L. Hewland.

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